MINISTRY OF FORESTS

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Forest Management in British Columbia

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Province of
British Columbia

Ministry
of Forests

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MANAGING FOR TOMORROW—
AN OVERVIEW

About half of British Columbia is forest land (51.8 million hectares); however, less than half of that land is managed as commercial forest. Some forest land is not suitable, some is inaccessible, and some has been allocated to non-timber uses. Between 1980 and 1985, an estimated 90 000 hectares of forest land, each year, were turned into roads, towns, farms, hydro developments, mines, parks and reserves, to name just a few. Today, only 26 million hectares of forest land are available and suitable for timber production.

To ensure that the impact on forest and range resources is assessed before more land is allocated to other uses, Provincial Forests were established in B.C. However, the creation of these administrative units does not mean that Provincial Forests are used exclusively for the production of timber and forage. The B.C. Forest Service is responsible for integrating the management of all forest uses in Provincial Forests. One of its basic objectives is defined in the *Ministry of Forests Act*:

> "to plan the use of the forest and range resources of the Crown, so that the production of timber and forage, the harvesting of timber, the grazing of livestock and the realization of fisheries, wildlife, water, outdoor recreation and other natural resource values are coordinated and integrated, in consultation and co-operation with other ministries and agencies of the Crown and with the private sector."

ECOSYSTEM TRAIL
BC FOREST SERVICE

Provincial Forests contain much more than trees. Through integrated resource planning, a wide range of forest resources are managed for many different uses.

Further, the B.C. Forest Service aims to manage these resources on an ecological basis. Forest managers recognize that many diverse ecosystems make up B.C.'s forest land, and they use information that researchers have provided about these ecosystems to plan and manage forest practices and activities. Managers rely heavily on forest research to improve and refine many of their techniques.

This publication will introduce you to the wide range of B.C. forest management practices and activities, and to some of the research related to them. However, a publication of this size can only cover these topics briefly.

For further information on any aspect of forest management and forest research, consult the offices and publications listed.

Forest managers use research findings about B.C.'s many ecosystems to manage forests on an ecological basis.

MANAGING FOR TOMORROW

Picture a forest. Wrap the scene around you. Can you smell the damp wood? Hear tiny feet scurry in the bushes? See sunlight break through sky-top branches and fall, flickering, on the forest floor?

People sense a forest in different ways. Artist Emily Carr saw it as a place where "the silence is full of sound and the green is full of colour."When she took her paints and canvas to the forest, she saw "themes everywhere, something sublime, something ridiculous, or joyous, or calm, or mysterious; tender youthfulness laughing at gnarled oldness."

Carr viewed the forest with great respect, much as the early Indians of British Columbia did. They were grateful for all the forest provided—berries, nuts, animals, and fish from forest streams. In the interior, Indians took lodgepole pine from forests to cover their pit houses and cottonwood to make buckets and canoes. Coastal Indians used the cedar tree extensively to make houses, canoes, dishes, baskets, poles, clothing, cradles, boxes and much more. Before they peeled the bark from the cedar, the Kwakiutl prayed to the tree:

''Look at me friend!
I come to ask for your dress,
For you have come to take pity on us;
For there is nothing for which you cannot be used...''

The first European to set foot in B.C. saw the forest as a great supplier. Captain James Cook sailed into Nootka Sound on Vancouver Island in 1778 and was delighted to find fir trees 80 metres tall and three metres thick. He needed replacements for the spars on his tall ships . "Luckily this country produces plenty of trees to supply us," he said.

As Europeans began to move into B.C., settlers were overwhelmed by the seemingly endless, dense forests. They used the trees for lumber and fuel, but they saw the forest as a major obstacle to roads, railways and settlements. They burned down huge forest stands to clear land for farms and ranches.

Early timber harvesters saw dollar signs in the forests. As wood markets grew in eastern Canada and abroad, B.C. experienced a timber boom. Timber harvesters mined stands of huge trees hundreds of years old. They believed the forests were limitless, so they harvested wastefully. No one took any care to see that new trees were replacing the old forests. The policy was simply, "Cut and get out."

By the early 1940s, B.C.'s forests had been seriously overcut in easy-to-reach areas. People began to get concerned. They saw the forest as a disappearing resource. To ensure that B.C. has trees for all of its tomorrows, there are now reforestation programs based on these government commitments:

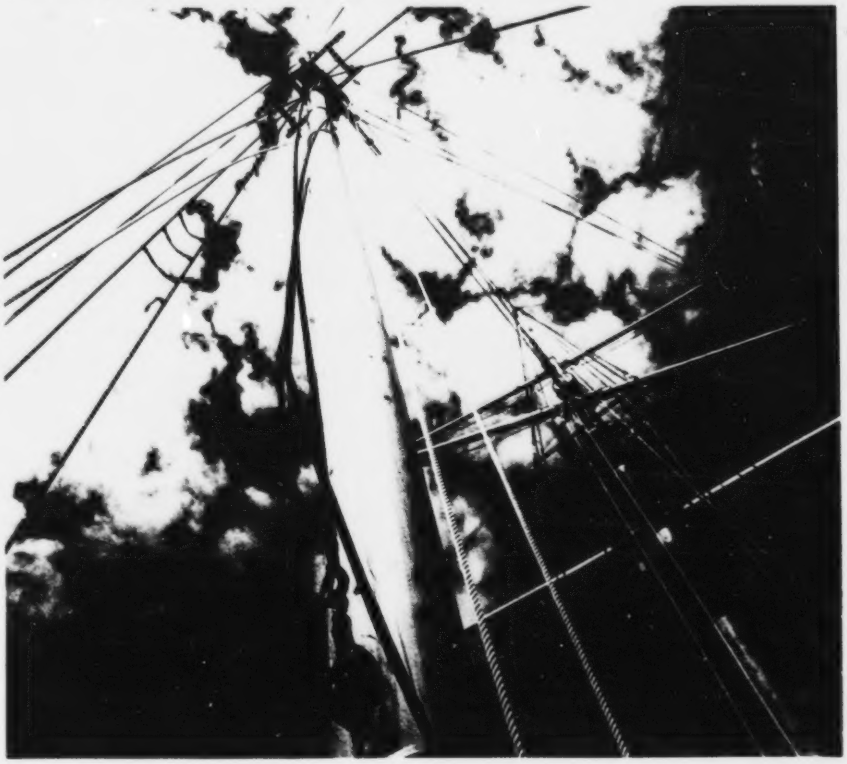
- the forest resource will be sustained--that is, productive forests will be maintained to provide direct and indirect jobs for almost a quarter million British Columbians; and
- the backlog of harvested land that has not been satisfactorily restocked—commonly called 'NSR lands'—will be reforested or reclassified.

Today, B.C. plants 65 per cent of the sites that are harvested in the province and is ensuring that the other 35 per cent are naturally regenerated.

Forest companies are now responsible, by law, for reforesting the areas they harvest. Before a company is permitted to cut a single tree, it is required to prepare a plan—known as a 'pre-harvest silviculture prescription'—of how it will reforest the area to a 'free-growing' standard. Public input is then invited and a cutting permit is issued only after the government is fully satisfied with the prescription.

The Indians were the first to use the B.C. forest; they treated the resource with great respect.

The first European in B. C. was Captain James Cook, who used fir trees from Vancouver Island as spars for his tall ships.



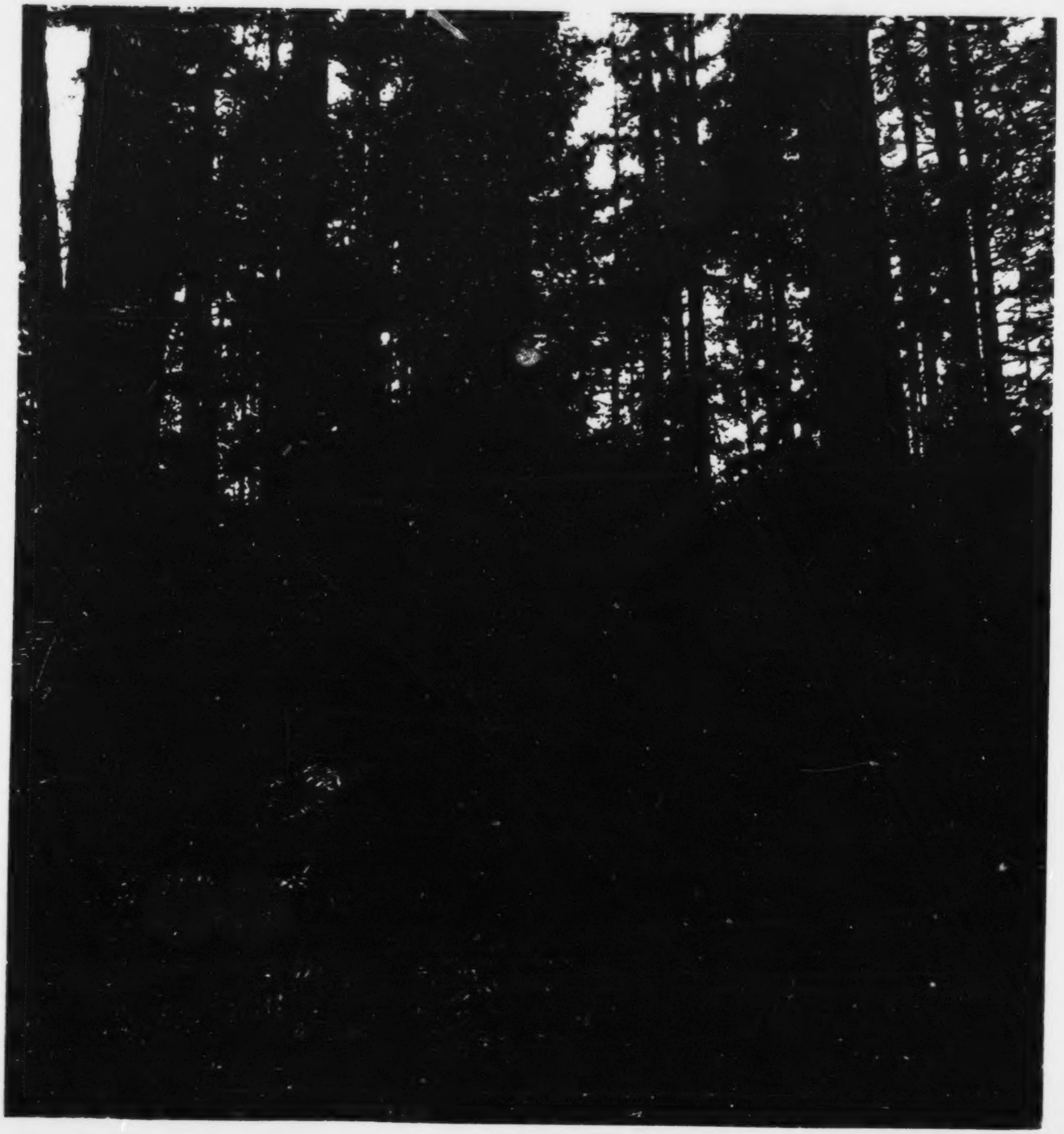
At the same time, the B.C. government is planting new forests on areas denuded by wildfire, pests, disease, and harvesting over past decades and which were not satisfactorily stocked.

B.C.'s reforestation programs are progressing well.

- The rate of tree planting has increased to the point where nearly 300 million seedlings will soon be planted in a single year.
- Sometime in 1989, the two-billionth seedling was planted—it took 50 years to plant the first billionth seedling and seven years to plant the second.
- The third billionth seedling is expected to be planted in 1991—a billion seedlings planted in five planting seasons!

Harvesting of naturally regenerated second-growth forests began more than 20 years ago, but the first forests planted in the 1930s by British Columbians, such as the Sayward Forest near Campbell River on Vancouver Island, will only be ready for harvesting in the 1990s.

This time period, however, is being shortened. Researchers are developing genetically superior seedlings that are growing faster and will also eventually produce higher-quality wood.



Managing a forest involves many different activities. In some ways, it is like managing a garden. Forest managers prepare the site after harvest so that new trees can be planted or can be naturally regenerated easily. As these grow, forest managers may weed and fertilize forest stands. They also try to protect the trees from fire, disease and insects. And they plan how much of each forest should be harvested, when and how.

But when forest managers look at a forest, they see much more than stands of valuable timber. They see habitat for wildlife and grazing land for cattle. They see forest rivers and streams that are habitat for fish and vital sources of fresh water. They also see a place of peace, beauty and recreation for thousands of B.C. residents and tourists. When they draw up their management plans, forest managers consider all the uses they see in a forest.

But do they have all the answers? Certainly forest managers have come a long way. They have improved their practices as the knowledge of forests and forestry has increased—and as social and economic goals have changed.

Still, forest managers have made their share of mistakes. In fact, they are only beginning to understand the complex nature of the forest—the interdependence of one aspect with all the others, and with the fish and the wildlife within the forest. As research unravels more of nature's mysteries and improves forestry practices, managers will be able to do a better job—to manage the forests for all uses.

As a British Columbian, you have a vested interest in forest management. More than half the land area of this province is forest, and most of it is owned by the people of B.C.—including you.

This publication gives you a closer look at the various practices involved in forest management in B.C. today:

- how seeds are collected, improved and produced;
- how seedlings are grown;
- how a forest site is prepared, planted, tended, protected and harvested;
- how forest roads are built; and
- how forest practices tie in with the management of watersheds, recreation, rangelands, and habitat for fish and wildlife.

Commercial tree species in B.C.

Most commercial tree species in B.C. are coniferous (softwoods). However, some deciduous species (hardwoods) such as aspen, alder, cottonwood and birch have also become commercially valuable.

Generally, the commercial tree species fall into eight categories:

- true fir or balsam;
- hemlock;
- Douglas-fir;
- cedar;
- spruce;
- pine;
- larch; and
- deciduous.

As research reveals more about the differences between forest types, forest planning and management will improve.

An understanding of forest management practices can help you become a better judge of the way your resource is being looked after. Further, it can help you provide stronger input to the forest industry and the B.C. Forest Service, who share the responsibility for managing the forests—the way you and other British Columbians see them.

Who manages the forest?

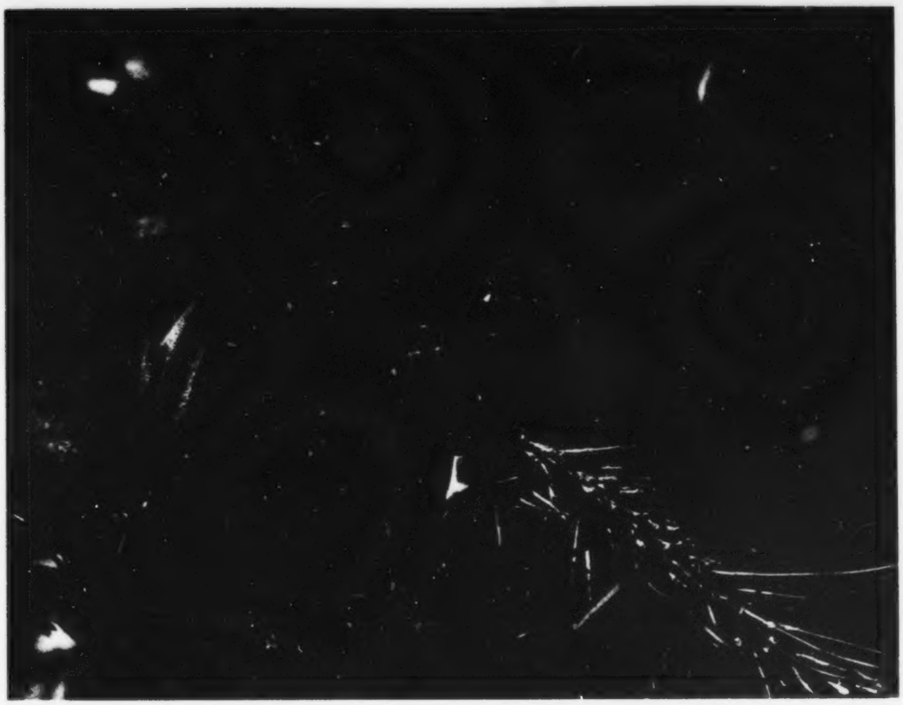
There are a great many foresters and forestry technicians involved in managing B.C.'s forests. However, forest management requires a wide range of expertise. Here is a list of just some of the other professionals and technicians who help manage the forests.

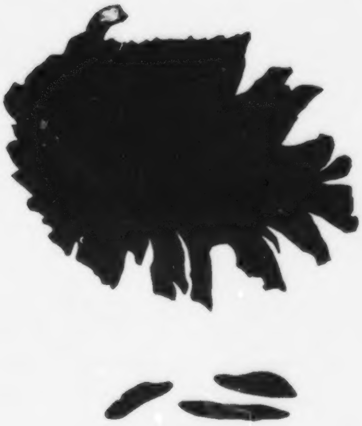
- Biochemists
- Biologists
- Biometricians
- Climatologists
- Computer programmers
- Economists
- Ecologists
- Engineers
- Entomologists
- Horticulturalists
- Hydrologists
- Landscape architects
- Nursery specialists
- Pathologists
- Planners
- Range agrologists
- Recreation specialists
- Silviculturalists
- Soil specialists
- Surveyors

STOCKING LEVEL
250 TREES
PER HECTARE

A variety of expertise is needed to manage forest land. Here, a silviculturist monitors growth in a research plot (right). Forest planners use computer programs to analyse landscape impacts (below).

SUPPLYING SEEDS





A tree begins life as a tiny package—a seed containing two or more "leaves," the bare beginnings of a trunk, and a root. The seed's size and shape, and the way it finds a place to grow depend on the tree's species.

Seeds from fir trees, for instance, are the size and shape of teardrops. Once released from their cones, the seeds flutter on filmy wings to the forest floor. There they lie, waiting for the warmth and moisture of spring to help them sprout.

On the other hand, seeds from lodgepole pines tumble to the ground, encased in small cones. The seeds are held captive until intense heat—from strong sunlight or fire—releases them to the soil. This is nature's way of renewing a forest. Many seeds are produced, but many take a long time to sprout; others don't sprout at all. Some fall in places that won't support the growth of healthy seedlings. Some fall on better sites, clustering so thickly that seedlings choke as they grow.

Forest managers want to control when and how seeds grow. They want to produce high-quality trees in a short period. Their way is to collect seeds, sow them in a nursery, then move the seedlings to good forest sites. Every year forest workers plant more than 200 million seedlings on land that has been harvested or burned.

Gathering enough seeds to grow millions of trees sounds like an impossible job. You might be imagining swarms of workers climbing up trees or scooping cones off the forest floor. In fact, collecting all these seeds really is a big job, but forest workers go about it systematically. They use a number of techniques and draw from two main sources—forests and seed orchards.

Seeds from the forest

During the late summer and fall, forest workers collect mature cones from selected stands throughout B.C. They take cones only from trees that produce abundant, high-quality seeds. As the cones are removed, workers carefully record their origin. That's so the resulting seedlings can be planted on similar sites—a factor critical to their survival.

Some species produce good cone crops only rarely. Spruce trees, for instance, produce cones in abundance only once in at least 12 years. When there is a good crop from species like spruce, forest workers make a special effort to gather lots of cones.

A helicopter is commonly used to collect

Tree Species at the Seed Centre

- Sitka, Englemann, white and black spruce
- Douglas-fir
- western and mountain hemlock
- western redcedar
- yellow cedar
- Tamarack and western larch
- Grand, Pacific silver and sub-alpine fir
- Lodgepole, white, Ponderosa (yellow), whitebark and limber pine

cones. Dangling beneath the hovering aircraft is a basket with a centre-opening rimmed with rake-like teeth. The basket is dropped over the tree's crown and, as the helicopter pulls up, the teeth strip off the cones and drop them into the basket.

In areas being harvested, some trees are felled for cone harvests. Crews use rakes to strip the cones from the branches, or they pull the cones off by hand. Sometimes they use machines to shake cones from standing trees or climb the trees to remove cones from the crowns.

Seeds from orchards

Forest managers establish orchards of high-quality trees in areas where warm, dry weather encourages the trees to produce lots of seed. There they carefully tend the trees to produce superior seeds.

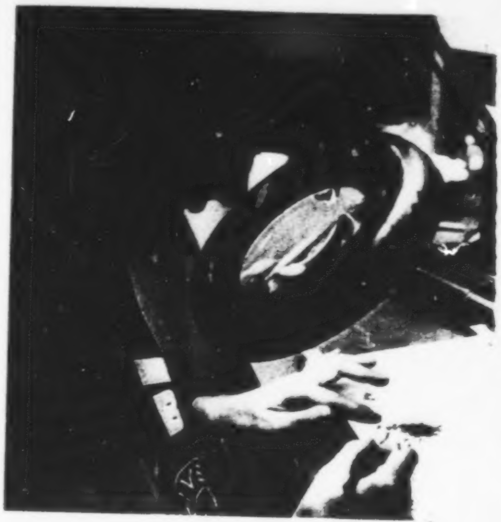
But where do orchards get all these high-quality trees in the first place? Tree breeders look in the forest for the best trees they can find—ones that are large, healthy and well-formed. The breeders take cuttings from the branches' tips, graft them to host trees and selectively mate these trees to produce good seed and seedlings. Or they collect cones from superior wild trees and sow the seeds in a nursery.

The resulting seedlings are planted at test sites where breeders measure growth and development. The measurements are used to rank the parent trees. Then the best parents are crossed to produce further improvements. The top seedlings in this new generation are used to establish a seed orchard—a "farm" that mass produces improved seed.

Tree breeders continually strive to make genetic improvements in the trees—and the seed—in the orchard. When the trees "flower," breeders cover female "flowers" with bags to prevent random pollination. Then they inject pollen from superior trees into the bags to produce top-quality seed.

As in the forest, cones in the orchard are collected when they mature.

The production of orchard cones and seed is increasing rapidly. Although most of the seed planted in B.C. today still comes from natural forest stands, seed orchards will likely become the main seed source one day.



Processing seed cones

Once cones from forest stands and seed orchards have been collected, they are inspected, measured, bagged and put into storage for curing. Then they are sent to a processing plant, such as the Seed Centre in Surrey.

Orchards in containers

Researchers in B.C. are experimenting with orchards of trees in pots. By keeping trees in containers in greenhouses, researchers control the orchard's total environment.

The potted trees grow fast. They produce an abundant supply of cones on a regular basis—and they produce them very early. Seed production begins just five to seven years after propagation, compared to 15 years or more for trees in regular orchards.

Researchers have greater control over the spread of pollen among potted trees. This provides them with opportunities to maximize genetic improvements in seeds and to introduce new and superior planting stock at an earlier time.

Trees of cones are kiln-dried (bottom). Then the seeds are extracted, cleaned and sized (opposite) at the Surrey Seed Centre. A sample from each seed lot is tested for purity, moisture content, weight, and germination potential.

Workers at the centre receive cones from all parts of the province. The cones are kept in lots according to species and areas of origin. This ensures that the seedlings produced from these cones will be planted on appropriate growing sites.

The cones are placed in a hopper, spread on trays and put into a kiln to dry for several hours. After the cones release their seeds, they are gently placed into a tumbler to shake the seeds out.

From there, the seed is passed through equipment that removes seed wings, debris and any damaged or empty seeds. The pure seed is dried until it contains only five to 10 per cent moisture. Then it is sized, cleaned and packaged in seedlots.

A sample from each seedlot is x-rayed and tested for purity, moisture content, weight and germination potential. Depending on the species and the seed quality, germination tests are repeated, now and then, to help determine the amount of seed needed to produce the required number of seedlings.

The seed is stored at -18° C. in vaults. At any one time, there is usually enough seed in the Seed Centre to grow more than two billion seedlings. Depending on the species, these seeds can be stored for 30 years or more.

All records on cone collection, extraction, processing and laboratory tests are kept in a computerized register. This Provincial Tree Seed Register and Inventory keeps track of the availability of seed for the province's reforestation program.

When the Seed Centre receives a request for seeds, packages of seed are taken from storage and soaked in water. Then they are chilled to break dormancy and induce sprouting. The seeds are sent out to nurseries and they are also distributed for a wide variety of research projects.

To improve the seed quality, the Seed Centre distributes cone-processing reports to all seed collection agencies. The reports contain detailed extraction and test results, and recommendations for improving seed quality.

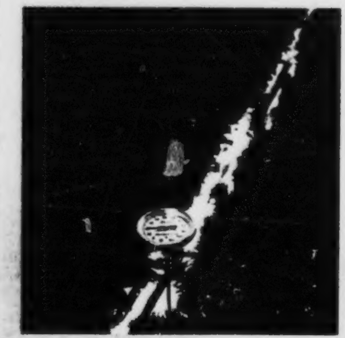
A helicopter lowers the basket over the crown and strips off cones from a high-quality tree.

Growing superior spruce from cuttings

Genetically superior interior spruce for reforestation programs are being propagated from rooted cuttings as well as grown from seed.

Researchers have been developing techniques for the mass propagation of juvenile spruce cuttings and transferring these techniques to forest nurseries.

The planting of interior spruce rooted cuttings can make a significant contribution to the reforestation of areas such as the Prince George region.



Improving seed-handling through research

Researchers are constantly looking for ways to improve seed handling at all stages—from gathering the cones to planting the seeds. Their efforts help to increase efficiency, and the survival and growth of the seeds.

One example of seed-handling research involves true firs—important timber and pulp-producing trees in B.C. Fir seeds usually need lengthy chilling to break dormancy. However, researchers discovered that if they first chill the seeds, then reduce moisture content and chill them again, the germination rates increase significantly. In fact, this treatment has increased the germination rate of dormant fir seeds five to 10 times. The treated fir seeds compete very favorably for light, water and nutrients—and they usually produce the most vigorous seedlings.

As nurseries start using this new treatment for breaking fir seed dormancy, they expect to make significant savings. Another research project involves B.C.'s provincial tree, the popular western redcedar. Its seeds are hard to sow. They are very small and irregular in shape, and they tend to stick together. Nurseries had to sow the seeds mostly by hand so workers were not able to meet the demand for western redcedar seedlings.

Researchers experimented with ways to make the seeds suitable for mechanical sowing, which is much quicker. They coated the seeds with fine clay to make them larger and rounder. This coating process is commonly used in agriculture on small seeds like carrot and onion seeds.

When nurseries began to coat redcedar seeds, they were able to sow them mechanically. The gains were immediate. Labor costs were reduced nine-fold and annual production of seedlings tripled. There was also an increase in the precision of the sowing. In turn, that reduced the number of seeds wasted. Later on, use of the coated seeds will decrease the amount of thinning needed in the nursery beds.

Making good beginnings

Without good beginnings, there are no good endings. Forest managers and researchers are working to make good beginnings by improving seeds genetically and processing top-quality seed. The quality of tomorrow's forests depends on it. As you read through the sections in this publication, you will see how efforts in planting, tending, protecting and harvesting the forest also help to ensure good endings.

Research into genetically improved spruce (top) and container seed orchards is an important part of reforestation efforts in B.C.

GROWING SEEDLINGS

A seedbed's warm moisture draws the tiny root out of a tree seed and down into the soil. Small green leaves press upwards, unfolding as they reach the air. Where there was only bare soil yesterday, a new seedling grows today.

The fragile seedling is on its own now. No longer can it rely on the food supply within the old seed coat. It must have water, heat and light to survive—and to grow, one day, into a tree.

Forest managers want as many new seedlings as possible to survive, and they don't want to leave that survival to chance. In B.C., nurseries raise millions of seedlings, providing optimum growing conditions until the young trees are strong enough to be planted on sites that have been harvested or burned.

Genetically improved, top-quality tree seeds are regularly collected, processed and stored. Nursery technicians draw this seed out of storage and plant it as needed.

But there is much more to growing seedlings than tossing seed into the ground. The seedlings must be raised to survive under the conditions of their eventual growing sites. Some seedlings will have to survive in cold temperatures and poor soils; others must adapt to hot, dry conditions. Therefore, the seedlings must be raised in the nursery according to very specific standards.

Many nurseries specialize in growing certain species and seedling types. There are two main seedling types: bare-root and container seedlings.

Bare-root seedlings

Bare-root seedlings are grown outside in the ground in seedbeds. They are called bare-root because their roots are bare—or free from soil—when they are planted at growing sites.

Each species of bare-root seedling receives its own specially prescribed set of treatments. A particular fertilizer blend is spread on the soil at specific stages during a seedling's development. A prescribed amount of water is provided at scheduled times, and roots are pruned to improve growth.

As the bare-root seedlings grow, their progress is monitored. If they are not developing as expected, nursery technicians modify the fertilizer, watering schedule or root-pruning to create the desired results.

Container seedlings

Container seedlings, also called plugs, are simply seedlings that grow in containers. They are raised, under cover, in greenhouses and shade frames.

Growing seedlings in containers is the preferred system for species such as hemlock and western redcedar. It is also used for many other tree species.

Thousands of container seedlings are grown inside a single greenhouse. The enclosed environment provides them with shelter and controlled amounts of heat, light and moisture. As for bare-root seedlings, irrigation systems automatically fertilize and water container seedlings according to specific prescriptions.

Unlike bare-root seedlings, the roots of container seedlings are still packed in soil when they are planted at growing sites. Container seedlings are easier to handle; and they are more resistant to damage, during transporting and planting, than bare-root seedlings.

Controlling disease and weeds in nurseries

Just as you try to control weeds and diseases to protect your garden plants, technicians work to protect young seedlings in the nursery. They

Nurseries grow bare-root seedlings in fields (left). Container seedlings, grown in styroblocks (bottom), are easier to handle (top).

try to control major plant diseases such as grey mould. It affects container seedlings in nurseries throughout B.C. and strikes most tree species grown for reforestation.

Grey mould control requires constant regulation of humidity, temperature and ventilation in green-houses. Nursery technicians also apply fungicides as needed under carefully controlled conditions.

Controlling weeds among millions of bare-root seedlings in open seedbeds is no easy matter either. There are few herbicides available for use in nurseries. However, nurseries have recently been testing a new herbicide, called oxyfluorfen. Researchers in Surrey have found that the low-toxic herbicide produces dramatic results. In test plots, metre-high weeds smothered lodgepole pine and Douglas-fir seedlings while plots treated with the herbicide were almost weed free.

A nursery worker removes weeds and culls from seedling styroblocks.

Leaving the nursery

Bare-root and container seedlings grow in nurseries for up to three years. The length of time depends on the species. It also depends on the conditions of the future growing site. Generally, older seedlings are planted on tougher growing sites.

Nurseries prepare seedlings for planting when they are dormant or after they have "hardened off," that is, after they have been prepared to accept poorer growing conditions. Technicians harden off seedlings by subjecting them to short periods of light or withholding water. This triggers a reduction in growth activity and makes the seedling less sensitive to damage.

After the seedlings are lifted from their beds or removed from their containers, they are stored in cold-rooms or shipped at once, in refrigerated trucks, for planting.

Nurseries go high-tech

Over the past two decades, the number of forest nurseries in B.C. has grown. Many nurseries have been converted to growing container seedlings. They have developed increasingly sophisticated practices, speeding up production to meet increased demands for seedlings.

For instance, at the Red Rock Research Station near Prince George, B.C. Forest Service researchers use state-of-the-art facilities to test nursery practices. They also monitor seedling storage, and evaluate the growth potential. Computer-controlled greenhouses enable researchers to set up experiments and track their progress precisely.

The computerized greenhouse controls at Red Rock replace older manual or clock-controlled systems. The new controls continually monitor the environment in the

Nurseries ensure reforestation of interior spruce

The interior spruce is vital to B.C.'s forest industry. In recent years, it has been one of the most harvested species in the province.

Although interior spruce reforestation is critical, the species regenerates very poorly on its own.

To ensure its survival, forest managers depend on nursery-grown spruce seedlings. In fact, interior spruce account for more than half the seedlings produced in all B.C. nurseries.

A researcher monitors progress in seedling development - part of the continuing effort to meet increasing demands for quality planting stock. Seedlings are shipped carefully in refrigerated trucks to planting sites.

greenhouses, maintaining correct temperatures and moisture levels. According to pre-set schedules, the system irrigates the seedlings and provides the exact amount of fertilizer they need.

The greenhouses are also equipped with curtains. Researchers use computers to raise and lower these curtains automatically to alter the length of "day and night." By fooling the seedlings, sense of time, researchers induce different activities, such as budding, or encourage seedlings to become dormant. The purpose is to produce high-quality, hardy seedlings as quickly as possible.

Keeping up with demand

As B.C. intensifies its efforts to replant hundreds of thousands of hectares of forest land, nurseries are stepping up their goals for seedling production. To achieve these goals and meet reforestation demands, nurseries need all the advanced technology and expertise they can muster. The future of B.C.'s forests depends on their continued efforts.

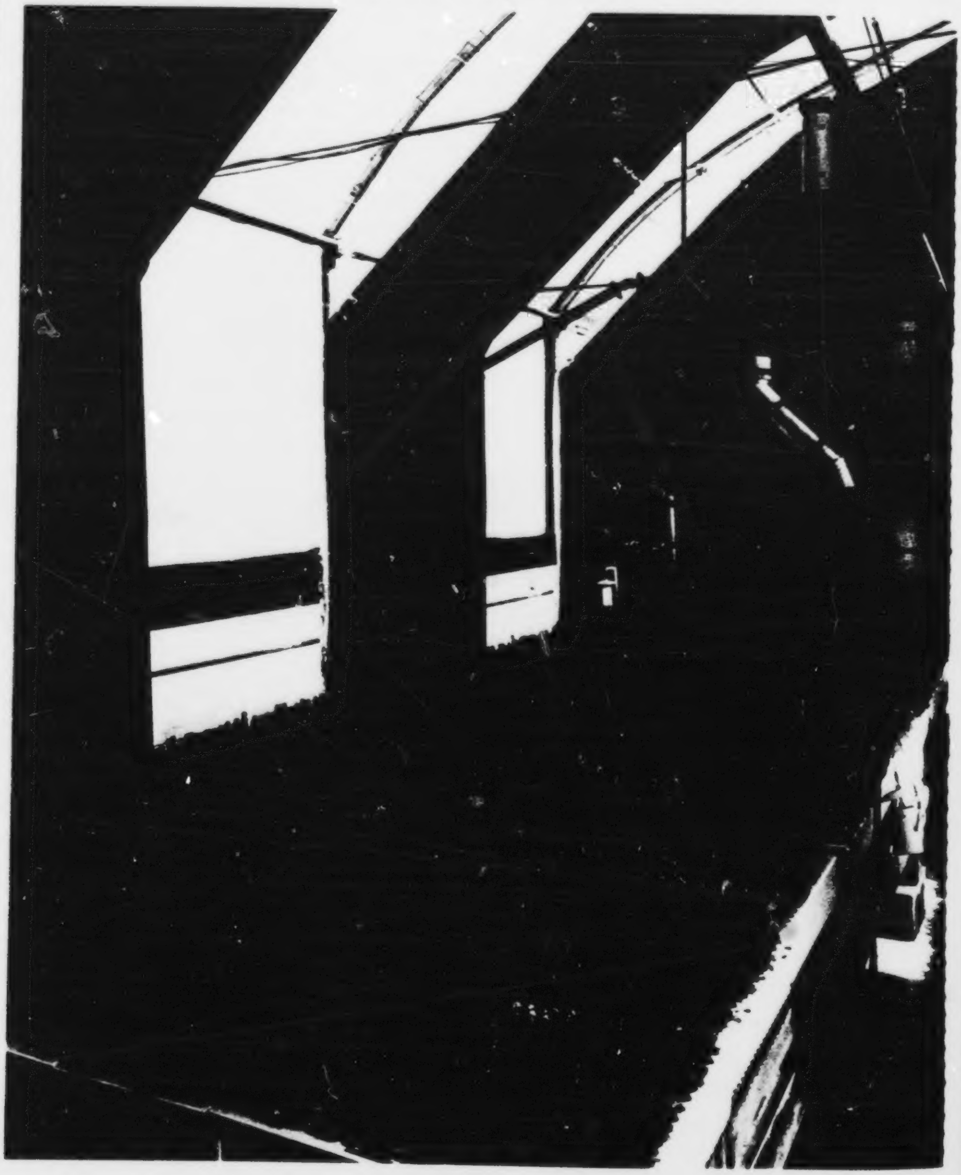
New technique determines hardening off

Nurseries had, for years, no easy, reliable way to tell if a seedling had hardened off. Then a research team at Simon Fraser University developed the "variable chlorophyll fluorescence technique."

As part of this technique, a seedling is placed in a sphere and illuminated to excite its chlorophyll.

The result is a fluorescent emission that indicates the photosynthetic activity level inside the plant.

A nursery technician can use this technique easily to see if it is safe to lift a seedling.



Hi-tech nurseries use state-of-the-art equipment to monitor experiments fostering seedling growth.

In the misty fall sky, a helicopter appears. It hovers noisily over a forest site cleared by timber harvesters nearly a year ago.

The scene is desolate. Stumps sit like islands amid a brown sea of branches, twigs, bark and needles. Remains of broken trunks and rot-filled trees criss-cross the landscape. Survivors of what was once the forest understory now grow in unaccustomed brightness, and new brush is creeping in.

The helicopter has been here before as forest crews checked on site conditions. On some days, the weather was very dry and windy. Today, the fallen needles and other fine debris on the ground are moist, and the air is still. It's time for action.

The pilot flies across the site, dropping inflammable pellets, like ping-pong balls, to ignite the debris from harvesting. Low flames creep across the ground's surface attacking stumps, trunks and branches. A forester stands watch and monitors the fire's heat. And just in case a wind should suddenly arise, a fire-fighting crew remains on the alert.

Gradually, the fire reduces the debris and uncovers the ground. Mop-up crews ensure that the fire is out and that it won't re-ignite later. By spring, planting crews will be able to work at the site. The seedlings they plant will be able to root and grow.

Site preparation pays off

The harvested forest site described above is fairly typical of harvested areas in B.C. Harvesting creates a huge volume of debris—needles, twigs, branches and rotten logs. It also encourages the rapid growth of vegetation that has no commercial value.

If harvested sites were simply left

A prepared site (top) is easier to plant than an unprepared site (bottom). Seedlings can get established sooner and more easily on prepared sites.

left alone, the forest would eventually regenerate on its own. However, it would take a long time. Up to 40 years could pass before new seedlings even got established.

Preparing the site to receive seedlings can reduce that time by up to 75 per cent in areas that regenerate naturally. The time can be even further reduced if the site is planted.

Sometimes the slash is too thick and inhospitable to plant seedlings so the harvested site must be well prepared.

Site preparation clears the area, encouraging growth so that new seedlings can root and take in the nutrients and moisture they need. Site preparation also controls competition from brush during the critical early stage of seedling growth. It reduces the fire risk by removing the accumulated fuel. And it makes movement possible for planters who, in turn, can distribute seedlings more evenly than nature might.

Not all sites need to be prepared. Some slower growing areas regenerate on their own. However, most are given a helping start through debris removal—even if the sites reseed naturally. Sites are usually prepared shortly after harvesting or a fire has occurred. Reforestation of these harvested or burned areas receives top priority in B.C.

However, site preparation is also done in areas that have not regenerated well over the years. Some of them have become overgrown with brush or commercially unimportant trees. Such poor reforestation results from wildfires, insect epidemics, unwise harvesting practices or other conditions, such as drought, that retards the seedlings growth. Under the Canada-British Columbia Forest Resource Development Agreement (1985–1990), forest managers have invested millions of dollars in improving these poorly regenerated sites.

Clearing sites by collecting firewood

You can cut free wood on harvested sites for your own personal use. In the bargain, you are helping to clear forest sites of debris.

The B.C. Forest Service issues permits for this kind of cutting. You may request one at your nearest B.C. Forest Service office. Stop by and find out what wood is available, and where and when to get it. (Access to firewood depends on its availability as well as the degree of harvesting activity and the risk of forest fires in the area.) Also ask for a brochure of safety tips for working around slash piles and cutting wood.

Site preparation methods

Fire is nature's own way of preparing a site for receiving seed. In B.C., prescribed burning—a controlled, intentionally-set fire—is the forest manager's most common way of preparing a site.

You have read how fires are set for site preparation. The tool for igniting the fire varies (for instance, sometimes drip torches are used instead of pellets), but the method of conducting the burn is basically the same from site to site.

Prescribed burning must be carefully controlled. Silviculturists want to ensure that enough of the organic soil layer will be retained to support new seedlings. And, of course, crews must take precautions to make sure that fire does not spread into adjacent areas.

Forest managers sometimes "scarify" a growing site—that is, they use heavy machines, such as bulldozers, to prepare the ground. They equip these machines with blades, chains or spikes to crush debris from harvesting and spread it about. They loosen the humus and churn it into the soil. Scarifying also reduces the risk of debris fuelling a wildfire.

Windrowing and burning is a site-preparation method that uses both machines and fire. Bulldozers push debris into rows or piles which crews ignite. Windrowing is sometimes used on sites where there is a lot of debris and where it would be hard to control a prescribed burn.

Herbicides might be used on sites where there is little debris but large amounts of unwanted vegetation. Crews apply chemical solutions to control the growth of competing plants so that seedlings can get established.

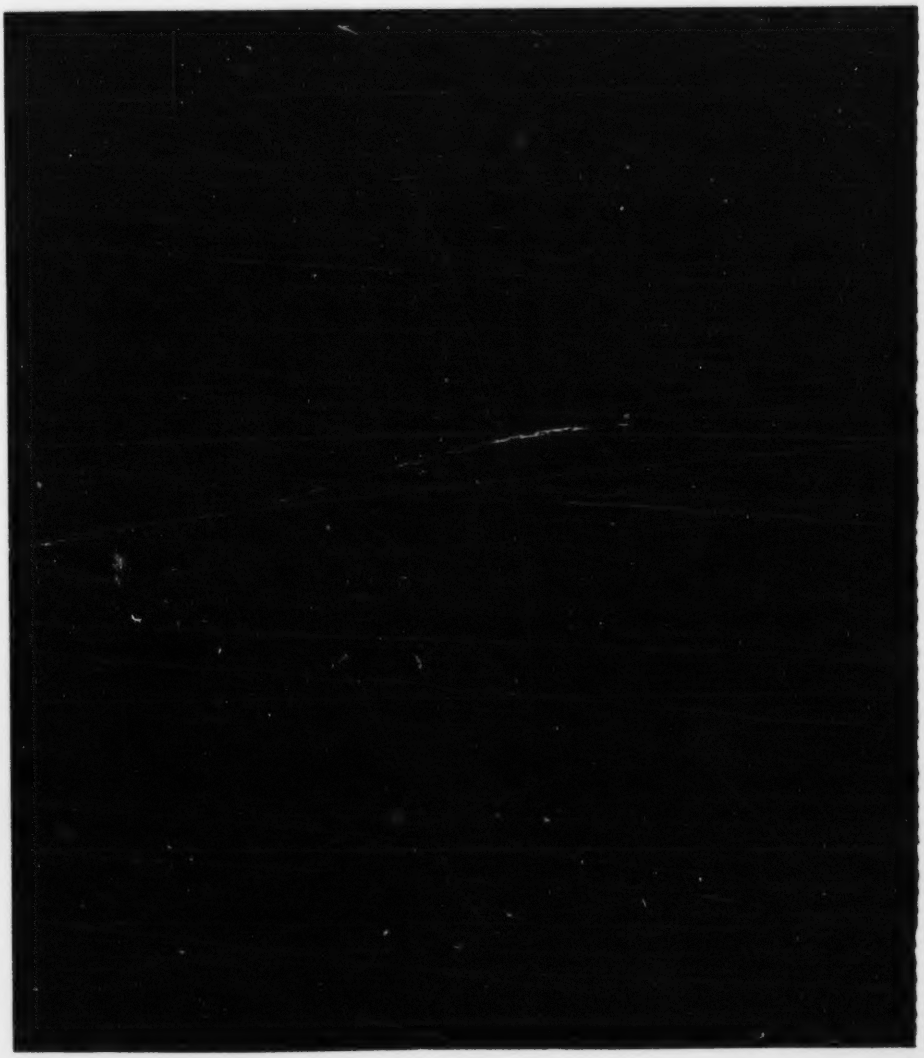
Choosing a method

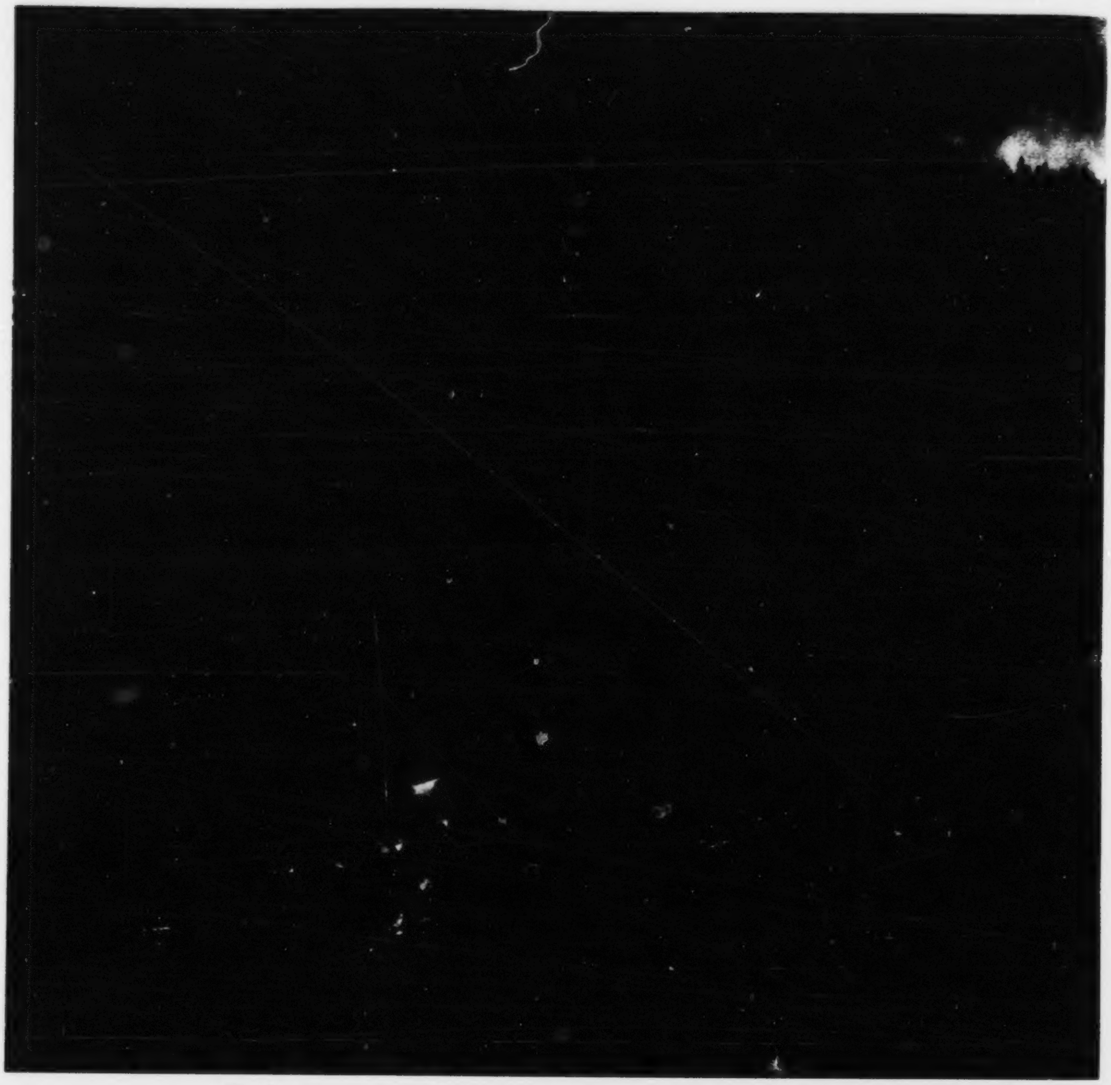
All site-preparation methods have the same goal: to prepare an area for regeneration. However, no one method is suitable for all growing sites. What works best depends on the ecosystem at each individual site and the tree species that will be grown there.

For instance, coastal Douglas-fir grows especially well on sites that have been prepared through prescribed burning. In the province's interior, scarifying promotes natural regeneration of species like lodgepole pine without burning thin layers of organic material. Machines spread out the cone-bearing branches of the lodgepole pine, exposing the cones to direct sunlight which, in turn, causes them to release the seed.

When forest managers choose a site preparation method, they also consider factors such as the site's slope. For instance, steep slopes should not be scarified. Heavy machinery can cause serious soil erosion. Machines can also compact the soil on growing sites. In some areas, both scarifying and windrowing remove valuable organic layers and upper layers of soil.

Conditions at each site determine the preparation method. In some areas, herbicides slow the growth of competing plants until seedlings are well established (left). In others, heavy machines prepare the ground for planting (right).





Prescribed burning is commonly used to prepare planting sites in B.C. (top) but not where it might harm other resources. Sometimes machines are used to break up debris and expose the soil for planting (bottom).

The forest manager evaluates the soil type, and the soil's depth, and the organic material on the site. Most nutrients occur in the litter—leaves and needles—and in the top 25 cm of the soil. If the soil would be damaged by fire, prescribed burning must be avoided. On any site, crews must avoid burning the ground so intensely that they reduce the nutrients.

Other resource uses are also considered. For example, prescribed burning may be avoided where fire and smoke would affect adjacent areas used for recreation.

And both herbicides and heavy machinery are kept away from areas where rivers and fish habitat could be damaged.

After considering the area and the species to be grown there, forest managers may decide to use a combination of methods to prepare a site. Or they may decide that no action is necessary at all. In the case of a site with a very fragile soil base, for instance, managers may decide to leave the ground undisturbed.

Whatever they decide, the site's condition—just like your garden's condition—determines how seeds or planted seedlings get established. It affects the success of the very earliest stage in forest growth. Seeing that sites are either naturally receptive or properly prepared is a critical first step in growing tomorrow's forests.

"It's the mosquitoes!" said the tree planter. "More than the back-breaking labor, more than the harsh weather, it's the mosquitoes that wear me down. Sometimes they're so thick they attack my eyelids—even when I'm wearing sunglasses."

The tree planter was discussing her part-time job in isolated pockets of B.C. She talked about the months of bending, digging and planting her way across some of the province's most rugged terrain. Yet she spoke of planting 1,000 seedlings a day—and planting them with care. "It's hard work," said the planter, "but it's satisfying. If you go back to a planted site a while later, you see the green-up. It's a whole new forest, and you know that you helped put it there."

Time to plant

Every year, thousands of tree planters spread across the province, creating new plantations on harvested or burned sites. Mostly, they plant in the spring—after the ground has thawed but before it has had time to dry out. They often begin work at lower elevations, then move up the mountains as spring clears the snow and warms the land.

On some parts of the coast, planters can begin work before spring. In areas such as the moist, northern interior, they can work during the summer. And under the right conditions, some forest sites can even be planted during a short period in the fall. The determining factor is weather; the soil must be moist and cool to receive new seedlings.

Planting by hand

Equipped with narrow shovels or pointed digging tools called "dibbles," planters work their way across a site. Bags full of seedlings sway from their belts as they walk. Every two-to-four metres, a planter selects a spot that is free from rock or debris. Occasionally some of the organic layer must be cleared to expose the soil. Then the planter digs or pokes a small hole into the earth and checks to see that the soil is deep enough to cover the roots of a seedling and to support a small tree.

On most slopes, seedlings must be planted by hand. Because the soil must be moist and cool, weather is critical to successful planting.

When planting bare-root seedlings, the planter first spreads the roots, then presses the soil firmly around them. The shaped roots of container seedlings, or plugs, are simply inserted into the holes. The soil is then backfilled against the roots to make sure there are no air pockets. With each individual seedling, the planter takes care to cover all the roots.

The planters work at a steady pace. The site is frequently large and the planting time short. Although they must keep moving, planters know that the quality of their work is critical. Each individual seedling must be given a good start. If it is poorly planted, the seedling can die—then both time and money are wasted.

Planting by machine

Because so much of B.C. is hilly or mountainous, many forest planting sites are fairly steep slopes. These sites must be planted by hand. However, on level ground or on slightly-sloped sites, machines do some of the work.

A planting machine is simply a tractor with attachments, such as a plow, for preparing the site. Each tractor tows a trailer carrying one or two operators. As the tractor moves across a site, a wheel cuts a furrow and a mechanical hand—or sometimes the operator's hand—places seedlings into the furrow. About 1,000 seedlings can be planted in just an hour.

Although planting machines work much faster than planters, use of the machines is very limited. Unlike a planter, machines

Room to grow

Each seedling needs sufficient light, water, nutrients and space to grow. Planters allow two-to-four metres between seedlings to avoid creating an overcrowded forest.

Early planting projects in B.C. were often too dense. These forests later required a lot of thinning to improve the growth of individual trees.

Spacing depends on factors such as the tree's species and the site's characteristics. A density of 1,000 to 1,200 seedlings per hectare is common. For current plantations, the survival rate of trees — one year after planting — is 84 per cent.

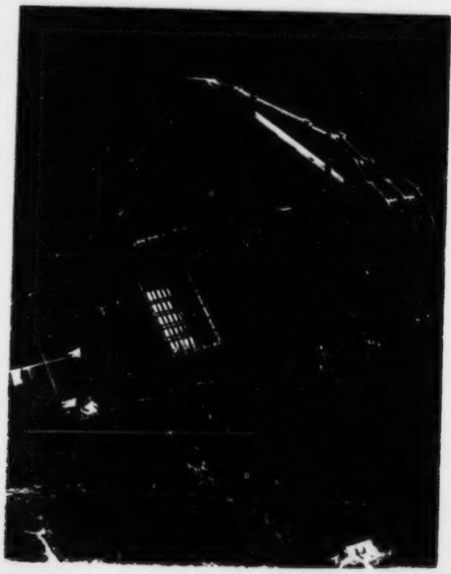
Forest managers purposely plan for the planting of more trees than are needed in the final crop. Mortality and competition cause a natural thinning.

If seedlings are planted too densely, their growth is inhibited. The well-spaced trees in this plantation are two-to-four metres apart (top). A mechanical mounder raises the soil temperature by scooping and heaping the soil before seedlings are planted. The process is especially important in areas with short growing seasons and high brush competition.

cannot choose the best spots to plant individual seedlings. Not only are they restricted to fairly level sites, they also require ground that is quite uniform—free of deep ridges or large wet spots. Further, machines are only used on sites where they can prepare the ground and plant the seedlings in one operation. The machines are not economical to use on sites that require some other form of preparation.

Improving planting through mounding

In their search for ways to improve the survival of seedlings, researchers have been studying the effects of mounding. Done by hand or by machine, mounding simply involves scooping soil out of the ground and inverting it in heaps. The soil temperature in mounds rises. In fact, on some cold sites in the northern interior, mounding doubles the soil temperature—raising it to about 10 degrees Celsius in early spring.



The warmer soil temperature promotes root growth. To the seedlings, that growth can mean the difference between survival or death. Especially in areas where the growing season is short, mounding before planting can be critical.

The right tree for the site

Sometimes the species that previously grew on a harvested site is not the most desirable one. Another species, or a mixture of species, may grow even better or produce more wood.

The decision to plant this or that species is not made just before the planters head off to the site. It is made before a forest stand is even harvested. A new forest policy in B.C. requires that a "pre-harvest silviculture prescription" be prepared and approved before any harvesting begins. The prescription describes how a new stand will be established on the harvested site. The choice of tree species is just one in a series of decisions including whether or not the site

should be prepared, how the site should be prepared, and whether it should be planted or left to regenerate naturally.

To make all these decisions, forest managers depend on information about the ecosystems at the site. They consider the elevation, climate, soil, terrain, water, drainage and the wide range of plants that grow there.

For example, forest managers examine the trees growing in an area and note their species, age and growth. They also take note of the variety of plants, herbs and mosses on the site. This vegetation yields information about the soil and the moisture available. On a coastal site, for instance, lady fern and salmonberry indicate plenty of moisture and nutrients. All this information helps forest managers predict which trees will grow best on the site—and under what conditions.

After forest managers choose the species they want to plant, they decide on the size of seedlings the site needs. Generally, it is wise to plant bigger seedlings where fast-growing brush creates stiff competition or where cool temperatures severely restrict the growing season.

Forest managers place their seedling order with a nursery well before they need to plant—even before a site is harvested. They inform nursery technicians of the seedlot that will suit the site. It is very important to plant seedlings grown from seed that was taken from an ecosystem similar to the planting site.

Checking back

One summer or a year after planting, forest managers return to the site to check on the seedlings' survival and growth. They may also make further checks after the second and third year. If the plantation is not growing as well as it should, forest managers often prescribe treatment, such as brush control. If the seedlings' survival rate is really low, a second planting may be necessary. It is becoming an increasingly rare event; but some years, drought or animals such as rabbits can damage or destroy seedlings, making a replanting necessary.

Forest managers do what they can to ensure a successful start for a new plantation. It is, after all, the culmination of years of work—gathering and improving seeds, growing seedlings and preparing a planting site; it is also the beginning of a whole, new forest.

A growing effort

Virtually no forest sites were planted before the early 1940s. Tree planting programs began slowly and increased very gradually. Only recently has there been an extensive planting program in the B.C. interior.

However, since 1976 planting has tripled. Even in difficult economic times, it has received high priority. During the recession of the early 1980s, planting continued to increase. Today about 200 million seedlings are planted each year.

More trees are needed, but an increased planting effort is being made. Due to a change in policy in 1987, holders of major cutting permits must reforest all areas harvested. For holders of minor cutting permits, provincial funds from the sale of timber are available for the restocking of harvested areas. As a result, the number of trees planted in B.C. will increase even further.

Forest ecosystems

The forests are made up of a number of different ecosystems—complexes of inter-related living and nonliving things, including soil and climate.

A rotting log can be an ecosystem, so can a stand of trees. Each part of an ecosystem is related to each other part; therefore, information about one can help predict growth or change in another.

Taking out the guesswork

The vegetation, geography and climate of B.C. are more variable than those of any other region in Canada. After years of study, researchers divided B.C. into 14 areas according to the vegetation, geography, soil and climate. They called these areas "biogeoclimatic zones."

B.C. Forest Service researchers refined the biogeoclimatic zone classification. Their ecosystem classification is the result of a 13-year program to organize detailed ecological information into a comprehensive framework.

Forest managers use this ecosystem classification to plan and manage forest stands. It helps them make decisions according to the characteristics and capabilities of a site. These decisions affect a wide range of forest practices and activities such as:

- preparing a site for planting;
- selecting the species and age of seedlings for planting;
- assessing the soil erosion risks;
- selecting a method for controlling competing plants; [illegible]
- choosing a [illegible]

This ecosystem [illegible] has helped forest managers take the guesswork out of forest [illegible]. It has also helped them avoid making some of the costly mistakes made in the past. For instance, when forest companies were just beginning to harvest trees at high elevations, they were replanting many sites with Douglas-fir.

They chose this species because it was commercially very valuable; however, the Douglas-fir seedlings grew poorly at high elevations. Several years later, they had to be replaced with other species.

The biogeoclimatic ecosystem classification is the most advanced ecological decision-making system in North America. It is used by forest managers throughout B.C.

Resource managers study each site's characteristics to determine the best forest practices to use

TENDING THE STANDS

Bundled into a plaid wool jacket and cap, the man hitches a Belgian horse to a single but sizable log. Sensing its load, the horse whinnies softly, anticipating the haul. Then the two set off. Puffs of fine snow dust the air behind the Belgian's hooves as the horse zig-zags its way through the dense forest stand. The only sounds come from the log skidding behind and the birds chirping above.

When they reach the road, the man unhitches the log and leaves it with the others to be collected by truck. He then turns back his horse for the next load—two smaller trees he has fallen and bucked, then choked together for hauling. The Belgian is easily able to pull more than its own weight. Before the day's end, man and horse will have removed nearly 17 cubic metres of wood from the very dense forest.

The timber harvester and his horse—one of about two dozen teams in B.C. today—are doing what forest managers call commercial thinning. Trees in overcrowded stands, 30 to 50 years of age, are removed to create more growing space for bigger or better-formed trees. If not removed, many trees would die anyway. When they are harvested, they are used commercially for pulp—or lumber if they are large enough.

Today, most commercial thinning uses light machinery to haul logs out of stands. Timber harvesters have to work carefully to avoid damaging other trees in the process. In most stands, thinning with machines is not a problem. However, in some stands, horse timber harvesting is still used. Occasionally, it can mean the difference between thinning or not thinning.

Growing a better forest

After all the time and effort that is spent collecting seeds, raising seedlings, preparing sites and planting trees, forest managers want to make sure that young plantations grow quickly and healthily. On some sites, that means tending the stands—giving them the various treatments that they need. With proper tending, seedlings can reach maturity significantly earlier and produce better quality trees than seedlings left to grow on their own.

One of the goals of stand tending is a commercial one: to produce a good supply of quality timber. However, healthy, well-managed forest stands also provide good habitat for wildlife and create opportunities for forest recreation.

Commercial thinning, using horses or machines, is just one of several stand-tending practices used in B.C. forests. This section will also look at managing vegetation, thinning young stands, fertilizing and pruning.

Managing vegetation

Good growing sites for conifers are also good growing sites for grass, brush and tree species that have low commercial value. These less-valuable plants compete aggressively with seedlings and young crop trees for light, water and nutrients. If the growth of less-valuable plants is not controlled, potentially productive plantations suffer serious set-backs from reduced growth and/or seedling survival.

However, forest managers do not want to eliminate non-commercial plants—they all have a role to play in the forest ecosystem. For instance, alder, a less commercially valuable tree, helps to put more nitrogen into the soil. Other trees, such as willows, are not valuable to timber harvesters but they are important to wildlife.

Forest managers only want to delay or control competing vegetation growth until young conifer trees can get ahead. Almost without exception, a wide variety of non-conifer species grows back in after conifer plantations are established.

Healthy forest stands do more than produce timber; they also provide good wildlife habitat and recreation opportunities.

On some sites, horses are still used to help thin dense stands.

After seedlings have begun to grow, forest crews use three main methods to control plants of low commercial value: manual, chemical and biological methods.

Manual methods involve hand-held cutting tools such as chain saws or brush axes. They can be used selectively on individual plants and in environmentally sensitive areas.

However, manual methods are expensive. They require large amounts of time and labor, and they frequently need repeating. Because cut plants often resprout, manual methods can even make matters worse. Cut aspen, for instance, often grows back thicker than ever.

Another serious disadvantage to manual methods is that hand-held cutting tools can easily cause serious injuries to workers. And a slip with a power tool can also damage young conifer trees.

Chemical methods use herbicides to control the growth of plants that have little commercial value. Sometimes herbicides are sprayed over large or inaccessible areas from helicopters or small planes. In small areas, workers use backpack sprayers to apply herbicides. Sometimes they selectively control the growth of individual trees by injecting a herbicide directly into the inner bark.

Herbicides can control competition long enough to allow conifers to dominate. Because few retreatments are required, herbicide applications are less expensive than other methods of controlling vegetation. However, no single herbicide can control all competing plants. And like all chemicals, herbicides must be applied with care.

Stand tending techniques, such as thinning, fertilizing and pruning, help ensure a supply of quality timber. In some areas, cattle grazing helps control competing vegetation.

Biological methods use mainly sheep and cattle to graze on less-desirable plants. Both the forest and the livestock benefit.

However, sheep and cattle can damage young conifers. They can also compete with wildlife for forage. The need for fencing, supervision and protection from predators, such as bears, can make this method of managing vegetation quite expensive.

Regulating herbicide use in B.C.

Applicators use only those herbicides that have been tested, approved and registered by the federal government. As well, applicators must hold a special provincially-issued permit (reviewed by five agencies) to apply herbicides on any site.

The herbicides must be applied according to label instructions, and strict federal and provincial regulations. These regulations protect the applicators and the public; as well as the environment, fish and wildlife, domestic livestock and domestic water sources.

Depending on the characteristics of a site, competing vegetation may be controlled manually (top) or with herbicides (bottom).

Choosing a vegetation management method

There is no all-purpose "best method" for controlling the growth of low-value vegetation. Each site is unique; each has its own needs. Forest managers choose the method—or the combination of methods—that best suits the site.

The choice of a method depends on many factors, including:

- the condition and size of the crop trees;
- what vegetation needs to be controlled and to what degree;
- how quickly the vegetation needs to be brought under control and for how long;
- the site size, accessibility, terrain and ecology of the site;
- the soil's susceptibility to erosion or compaction;
- the needs of other resources in the area (there may be bodies of water to protect, fish and wildlife habitat to maintain, or recreation and trapping areas to preserve);
- the public's and the forest workers' health and safety;
- the availability of labor, equipment and money; and
- any legal or policy restrictions.

It is critical that forest managers choose methods that are economically, silviculturally and environmentally sound. Through comprehensive research, managers can refine and improve their methods of managing vegetation.

Thinning

Competition for space, light, moisture and nutrients is never-ending. If some of the trees in an overcrowded stand cannot meet basic needs, they may become stunted or die. Sometimes the whole stand suffers from intense competition, and none of the trees within it grow to their full potential. When a stand is just 10-to-20-years old, forest managers can judge its potential for growth. They can also judge the quality of individual trees. Crews often thin out the inferior ones. Because this practice is carried out when the stand is young, forest managers call it "juvenile spacing." It is also called "pre-commercial thinning" because the harvested trees have little or no commercial value. They are usually left on the site to decay and enrich the soil.

Just like the commercial thinning discussed at the beginning of this section, pre-commercial thinning creates more space for the better trees. Forest crews leave a set distance between trees. For example, on some sites, they aim to leave four metres between trees in a triangle but make sure only quality trees remain. Sometimes, they leave even more space if they want to avoid doing a second thinning later on.

There are many advantages to thinning. The remaining trees grow larger and reach maturity sooner. Thinning can increase the yield of usable wood from mature stands by five to 30 per cent and significantly reduce future timber harvesting costs on the coast. It can reduce the incidence of disease in a stand by removing infected trees and raise the quality of the wood produced. It can promote the growth of forage for elk, deer and moose and make some stands more accessible to both wildlife and recreationists. However, in very dense forest growth, thinning makes stands less accessible because the felled trees become a barrier.

Fertilizing

Nature gradually adds nitrogen, iron, calcium and other nutrients to the soil by decaying twigs, logs and other matter on the forest floor. After thinning operations, forest crews leave some of the branches and logs to rot and return nutrients to the soil. On some sites, they also add pellets of nitrogen fertilizer, using helicopters and small planes to spread the pellets over large areas.

Not all species benefit from fertilizer. For instance, additional nitrogen can increase growth in coastal Douglas-fir by as much as 15 per cent, but it doesn't consistently improve the growth of hemlock.

Forest managers fertilize only those sites where sufficient nutrients are not naturally available and where the stand is in condition to respond. Trees must have enough space to grow when stimulated by fertilizer. For the very best results, forest managers combine an application of fertilizer with thinning.

Just one application of fertilizer can improve a stand's growth for six to eight years. It can create a significant increase in yield. Further applications of fertilizer can produce even more high-quality timber in less time.

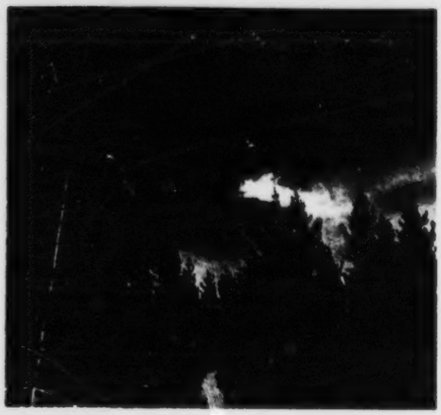
Pruning

Forest managers have been experimenting with ways to produce more knot-free wood by cutting off the lower branches of young, widely spaced trees. Because this pruning requires a great amount of labor, it is an expensive practice. However, it is economical where there is a premium price for knot-free lumber.

Pruning does not harm trees. In fact, it can help to protect stands against diseases that are spread among low branches. For instance, the dreaded white pine blister rust, a killer of B.C.'s native white pine, can be slowed by pruning.

Improving tending through research

Farmers are able to watch the crop that they sow grow from start to finish in a single season. They can judge, for themselves, the value of certain fertilizers or methods of weeding. However, forest managers rarely see seedlings grow into mature trees. Even if they did, they wouldn't want to wait 50 to 60 years or more to judge the effectiveness of their stand-tending practices. Instead, forest managers turn to researchers for advice.



Researchers conduct "growth-and-yield" field experiments to test the effectiveness of practices, such as planting or thinning, on the growth of trees in a stand. They set up test plots and note the trees' development and the sites' characteristics.

Some test plots in B.C. date back as far as 1929. Researchers have used these plots to measure the long-term effects of repetitive thinning on coastal Douglas-fir. However, many test plots were established much more recently. Although they will provide valuable information one day, they leave many current questions unanswered. For instance, very little is known about the growth of some key interior species such as white spruce and lodgepole pine.

Therefore, researchers turn to sophisticated computer simulation models to help them predict the effects of stand-tending practices. Researchers first measure and observe hundreds of real trees, bucking their stems, splitting their branches and excavating their root systems. They use all that information to create a mathematical model of the way the trees grow. Using a highly specialized computer program, the researchers then use the model to simulate the future growth of a stand.

Next they run "experiments" in the computer to see how the timber yield might be affected by one or more stand-tending practices. They project the effects of managing vegetation and of thinning, fertilizing and pruning. For instance, they estimate how much knot-free wood could be produced by pruning.

Although computers can only provide educated guesses or predictions, they are able to provide guidance for stand-tending questions in just seconds. Instead of waiting a lifetime to see results, forest managers are able to sit at computers and trace the simulated

High density sheep best

Researchers have been studying the effectiveness of sheep in controlling plant growth in B.C.'s Cariboo region.

Based on the results, they recommend grazing 40 to 50 sheep per hectare to remove 50 to 75 per cent of the non-crop vegetation.

They also suggest rotating the sheep to new sites within 10 days. That improves the effectiveness of the grazing and prevents browsing damage to conifer seedlings.

For best results, forest managers often thin stands to reduce competition (bottom). Some stands can benefit from aerial application of fertilizer pellets (top).

effects of stand tending from the bare forest site right through to the harvest.

Worth the effort

Across much of British Columbia, new forest stands are replacing old-growth forests. The transition is challenging forest managers. They must be able to raise fast-growing, high-quality, large-sized trees to meet predicted demands for timber. They must also be able to meet the demands of other forest users.

Stand-tending practices are helping forest managers meet these demands. The heavy investments they are making in researching and applying sound stand-tending techniques are proving to be well worth the effort.

Pruned trees can yield valuable, knot-free lumber.

PROTECTING THE FOREST

Orange fire licks the sky as grey smoke billows from the forest. After a long, hot summer, the area is tinder-dry. What is now just a patch of trees in flame could quickly become a major forest fire.

Spotted by the pilot of a small commercial plane, the fire is reported to the Flight Services Station at the Penticton airport: "Fire, six kilometres north of Naramata. Roughly the size of a baseball diamond. Flames reaching tree tops. Mainly pine trees and brush." The report is passed at once to the B.C. Forest Service.

Within minutes, a bird-dog plane leads two air tankers straight to the fire. They drop a load of orange fire retardant to cool things down. Right behind them, a helicopter moves in and hovers over the fire.

A rope attached to the helicopter is dropped several metres to the ground. Then a brightly-clad figure, trained in the art of rappelling, steps onto the helicopter skid and quickly descends the rope. Seconds later another member of the rapáttack team follows. Before the helicopter leaves, an equipment bag drops down the rope to the ground.

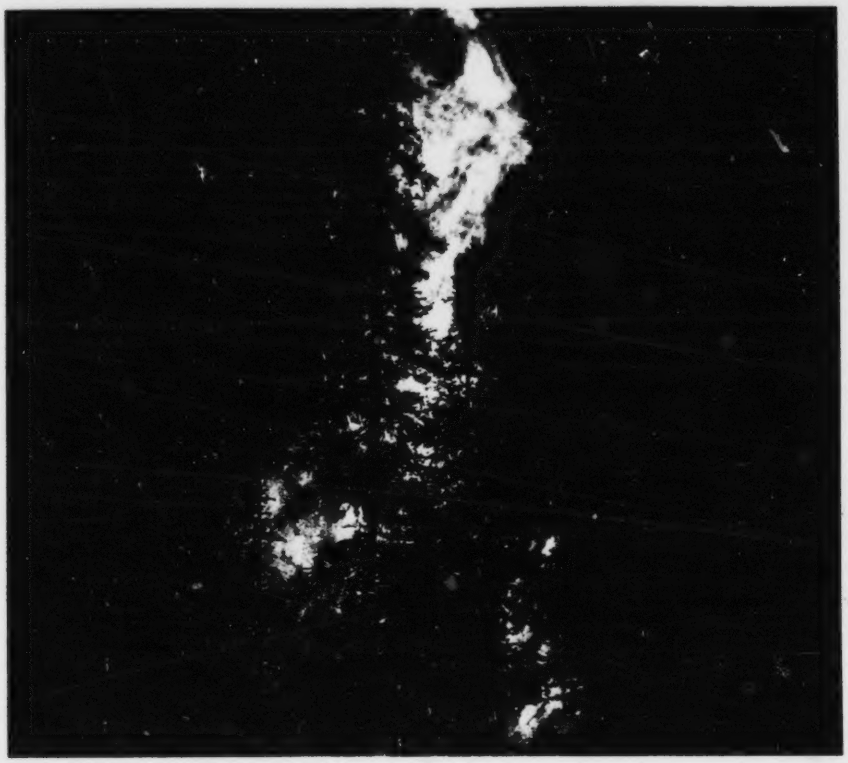
Working quickly, the team turns its attention to curbing the fire, cutting firebreaks and digging ditches. When the helicopter returns, it brings 600 litres of water and foam in its belly tank to support the rapattack team. In just under three hours, the fire is under control.

Facing the enemy

Every year, about 2,800 fires attack B.C. forests. Most of these fires are extinguished quickly—while they are small. Others rage out of control, destroying thousands of hectares of trees, and threatening life and property.

Forest managers give high priority to protecting forests from fire, but they also recognize an even greater threat—insects and diseases. Together with fire, these pests destroy about 22 million cubic metres of timber each year—about one third as many trees as are harvested. That not only means serious wood losses; it can mean also damaged soil, reduced water quality and loss of wildlife habitat.

This section looks at the efforts to prevent, detect and control fire, insects and diseases in B.C. forests.



Preventing forest fires

Although lightning causes forest fires, many fires are caused by human beings. They are responsible for about 60 per cent of the forest wildfires in this province. Arsonists start an average of 144 forest fires a year, but most fires result from accidents or careless acts such as failing to put out a campfire or tossing a smouldering cigarette into forest fuels. Most

Helicopters drop trained initial attack crews and equipment to fight wildfires as quickly as possible (bottom).

What can you do?

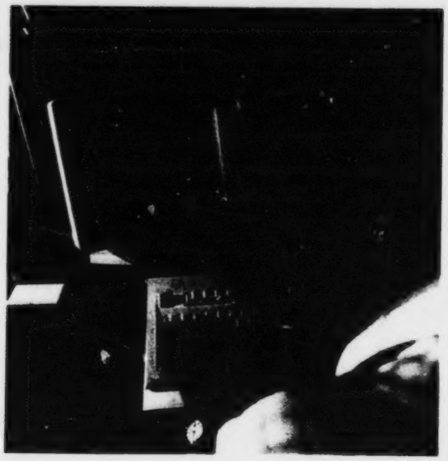
You can help to prevent and detect forest fires. Here's how:

- extinguish matches and cigarettes completely;
- follow all regulations that govern campfire use (check with the B.C. Forest Service for a brochure of regulations and safety tips); extinguish hot briquettes or bury them in 30 centimetres of soil;
- obtain a burning permit for all open fires, except a campfire, during fire season (normally April 15 to October 15); depending on the area, permits are available from your fire chief, municipal authorities or the B.C. Forest Service;
- burn only during still, damp weather, and away from buildings trees or grass; stay with a fire until it is completely out, and keep a hose handy to prevent it from spreading;
- call the RCMP if you have any reason to suspect arson; if your information leads to the conviction of an arsonist, you may receive a reward; and,
- report all forest fires at once by dialling "0" and asking for Zenith 5555, a free, province-wide forest fire emergency number.

forest fires can be prevented.

The forest fire risk increases during hot, dry weather. The B.C. Forest Service may restrict travel, burning and other activities such as berry-picking, hunting, fishing and camping in the forest. Industrial activities may also be restricted so that crews do not work during the riskiest parts of the day or season. During times of extreme hazard, all forest activity may be prohibited.

Debris from harvesting, and dry grass and shrubs can become natural fuel for wildfire. Forest managers may prescribe controlled fire to eliminate this fuel. However, they only prescribe fire on sites where it plays a natural role in the ecosystem, and they prevent the prescribed fire from escaping by burning under carefully controlled conditions.



Foresters use electronic equipment to monitor fire hazards (bottom). They track the status of all fires (top).

Detecting forest fires

In an average year, the public reports about one third of all forest fires—more than any other single source. Another quarter is detected through B.C. Forest Service lookouts and air patrols. During high fire-risk periods, ground patrols also check heavily used recreation areas for wildfire signs.

The best detection, of course, is early detection. To detect lightning strikes quickly, forest managers have established a series of lightning locators throughout B.C. As soon as a lightning strike is detected, it is reported to a computer in Victoria. The computer calculates the latitude and longitude of the strike in just three seconds.

New computer technology links the information from lightning detection equipment with information on weather, fire-danger ratings and other data. It's all part of an advanced fire-management system that predicts the number of lightning and people-caused fires that may occur in specific areas. That makes it easier to allocate provincial resources such as fire-fighting crews, helicopters, air tankers and other equipment.

The advanced fire-management system also shows what a particular fire might do and predicts how fast it may spread. Every day the system produces several maps that show how much moisture is in the fuels on the forest floor and in the deep soil.

Controlling fire

In B.C., forest fires must be hit hard and hit fast. Fire bosses aim to control fires within 24 hours; they are successful nearly 90 per cent of the time.

As soon as the alarm goes out, bird-dog planes speed into action. They direct fleets of fixed-wing air tankers that drop retardant. It reduces the blaze and slows the fire's advance until initial attack crews arrive. These may be ground forces or helicopter-borne helitack or rapattack teams. They bring small fires under control and keep larger fires from spreading until support crews reach the scene.

Support crews may suffocate fire with dirt and water. They may cut a break through the forest to contain the fire. If water is available, they may use portable pumps to extinguish smouldering fires. And they check spot fires that move ahead of the main fire.

During major forest fires, crews and machines dig or scrape out a trench to stop the fire in its path. The trench incorporates natural barriers such as streams or lakes. Then the crews burn the area between the trench and the leading edge of the fire. In effect, that removes fuel and "starves" the fire. In the meantime, fire fighters attack the rear of the forest fire with pumps and hoses, axes and chainsaws.

Once a fire is controlled, mop-up crews move in. They extinguish burning or smouldering material, cut down snags and use infrared scanners to hunt out hot spots—areas that retain intense heat. Planes and helicopters using these heat-sensing devices can detect hot spots that are not visible from the ground. Then crews patrol the areas for days or weeks to make sure that fire does not break out again.

Preventing losses from forest diseases and insect invasions

Every year, insects deform, weaken or kill trees worth millions of dollars. They attack forests, eating seeds, cones, leaves, twigs, bark and wood. Mature and over-mature trees are especially vulnerable to attack. Even after the trees have been cut, they may be invaded by insects.

Forest managers try to prevent damage from insect invasions in the first place. For instance, they may use artificial pheromones (chemicals produced by insects to communicate with or attract other insects) to attract bark beetles to stands that are about to be harvested. That way the beetles are removed from the forest before they cause any damage. Another use of pheromones is to trap ambrosia beetles that attack logs. Damage from these beetles can also be prevented by removing the trees soon after they have been felled.

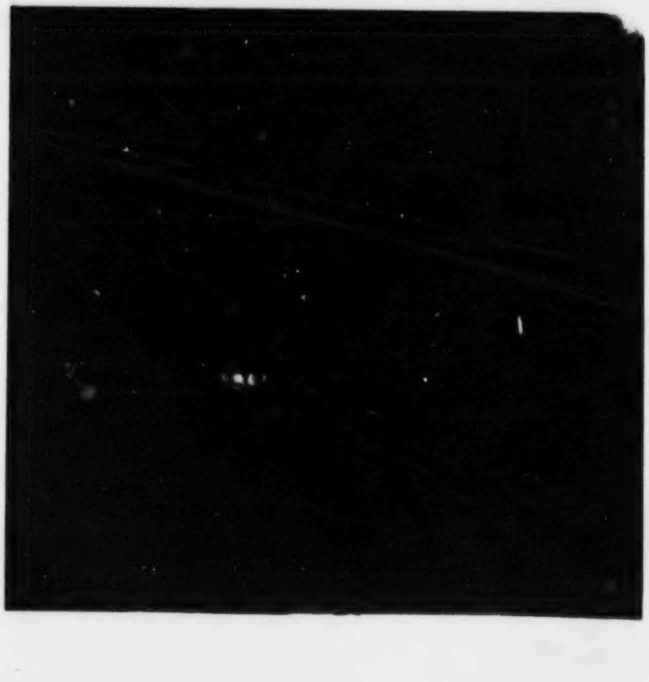
About 40 per cent of the trees lost to forest pests each year are due to fungal diseases, such as decay and root rot (which can survive up to 100 years), and to parasitic plants, such as dwarf mistletoe. Bacteria and viruses also attack trees.

Forest managers try to prevent the spread of these tree diseases during normal forestry operations. For instance, they thin young stands to decrease the amount of decay and harvest mature trees before decay sets in. By planting trees that are less susceptible to root diseases and extracting large roots after

Frightening forest fire facts

- A bolt of lightning, a major cause of forest fires, can be five times hotter than the sun's surface. More than 200 bolts strike the earth every second.
- Fire can travel faster than you can run and it can create enough heat to melt metal.
- Heat, smoke and falling debris from a forest fire can be as dangerous as the fire itself.
- Several forest fires can come together, creating an inferno known as a fire storm.
- Fire can create hurricane-force winds that toss whole trees into the air.
- For every 30 centimetres along the fire front, a large fire produces as much energy per second as three gas-fired home furnaces.

Trained, hard-working personnel are the key to B.C.'s highly successful wildfire control program.



Letting fire go

Although forest managers have been fighting fires in B.C. since 1912, they do not fight every fire to the end. If the initial action is unsuccessful, they may decide not to continue fighting it.

In remote areas with low forest values, and where fires may actually enhance values, forest managers may let fire run its course and put fire-fighting resources to better use in other parts of the province.

Sometimes forest managers will let a fire burn through stands that are diseased or heavily infested with insects. The fire clears dead and dying trees.

Some areas, such as ecological reserves and designated wilderness areas, are highly valued for their naturalness.

Depending on the unique combination of conditions in each site, forest managers may modify their control operations for wildfires and diseases. The decision not to fight a fire is made very cautiously and only after the surrounding values are analysed and the risks are assessed.

harvests, the spread of root rot is reduced. Dwarf mistletoe is controlled by clearcutting, then burning infected trees.

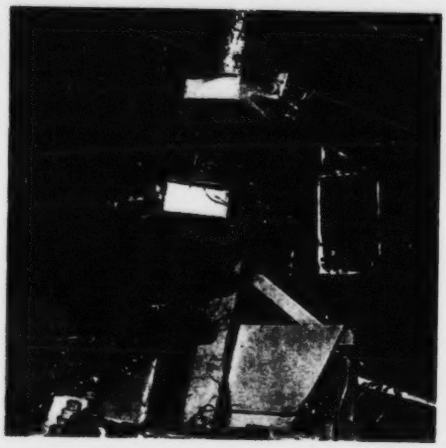
One of the best methods of preventing forest disease and insect infestations is to maintain healthy forests that resist attack. That may include selecting disease-resistant seedlings for planting or choosing a mix of species to avoid having epidemics sweeping through the stands. Further, if stands are harvested at age 70 instead of 300, for example, they will likely contain less decay.

Vigorous, healthy stands are less likely to come under attack. However, like humans, our forests are sometimes subject to health problems and need the care of pest specialists. Prevention is still the best care.

Detecting insects and disease

Early detection of pests, like early detection of fires, is critical. The most effective treatments are those applied at an early stage.

Aerial surveys can monitor large areas at minimal cost. They can detect outbreaks of pests such as bark beetles and many tree defoliators—the damage is visible from a distance. Then ground surveys confirm the outbreaks and gather detailed information.



Problems such as root rots or dwarf mistletoe are hard to detect from the air. Forest managers depend on ground surveys to find and assess these pests. Sometimes forest workers also report damage.

To control the spread of diseases, forest managers sometimes remove infected trees from stands (top) and dig out large roots (bottom).

Battling bark beetles

Since the mid-1970s, bark beetles have been one of the most serious insect problems in B.C. forests. Two species, the mountain pine beetle and the spruce beetle, have caused extensive damage to mature stands of lodgepole pine and spruce.

The beetles bore under the bark and eventually kill the trees. Because bark beetles spend most of their time beneath tree bark, pesticides cannot be used to control them. Instead, crews fell and burn individual trees to destroy the insects before they spread to other trees. Sometimes crews have to harvest large patches of infested trees.

In 1984, forest managers expanded their program to curb the spread of bark beetles. They conducted extensive surveys to detect the extent and severity of the infestations. Then they used this information to develop timber harvesting plans, giving priority to infested, high-risk areas.

Once on top of the problem, forest managers will continue to monitor bark beetles and deal with future infestations at an early stage.

Dwarf mistletoe is not romantic

Dwarf mistletoe is one of the most damaging pests in the forest.

It feeds and grows on B.C.'s most important tree species: western hemlock, lodgepole pine, western larch and Douglas-fir.

Although it usually doesn't kill trees, it steals nutrients, severely reducing growth.

Controlling insects and disease

Most efforts to control insects and disease are efforts to prevent their spread. However, when pests seriously threaten forests, managers take further action. They consider the nature and extent of the problem, the species of trees, the treatments available and the effects of these treatments on all resources—not just on the trees. They also compare the value of the resources with the costs of treatment.

Some problems may call for treatments such as clearcutting infected stands or spraying trees with chemical pesticides. Forest managers may also use a biological agent such as a virus, disease or insect that attacks the pest.

The use of forest pesticides—chemical and biological—is stringently controlled. Pesticides are approved and registered for use in Canada only after extensive research and an intensive review process coordinated by federal authorities. In B.C., the use of pesticides is further regulated. Applicators must acquire permits to use pesticides on each particular site. They must follow strict federal and provincial regulations in applying the pesticides.

Forest managers only use pesticides when the use is justified—both environmentally and economically. They are used less than any other tool to control forest insects and disease.

Through research and experience, forest managers are learning more and more about the insects and diseases that attack trees. Armed with that knowledge, forest managers can improve efforts to prevent infestations and deal more effectively with the outbreaks that occur. These efforts, combined with strategies to fight wildfires, help to protect all of B.C.'s forests.

The damaging dwarf mistletoe can be controlled by cutting and burning infected trees.

Some species of harmful insects can be attracted to a trap-tree containing artificial pheromones attractants. Then both the tree and the insects are destroyed.

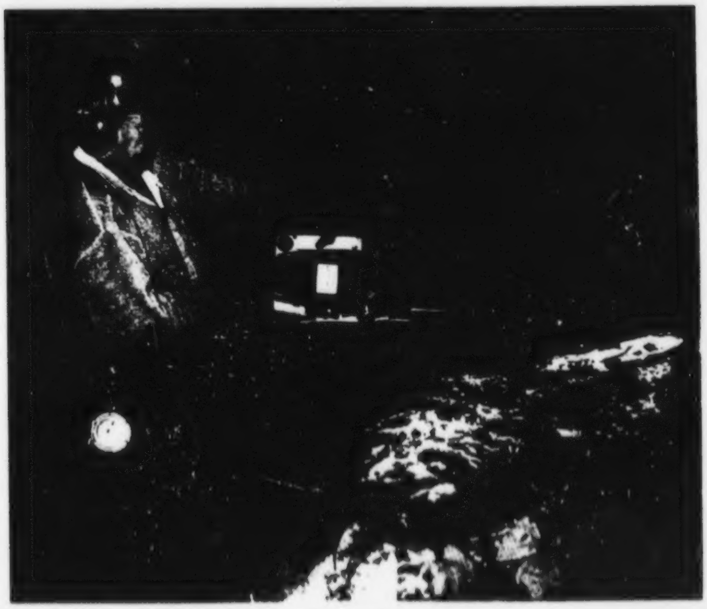
Infestations of bark beetles have damaged extensive stands of pine and spruce in B.C. (overleaf).

Harvesting today compared to 100 years ago

Segments from a video script comparing harvesting today with harvesting a hundred years ago might read like this:

Opening scene:
Coastal harvesting site, 1889.
Action:
Two harvesters in "tin pants" (waterproofed with animal grease), plaid mackinaws, wool caps and caulk boots stand on springboards 1.5 metres up on the tree, using a crosscut saw.
Wide shot:
The tree begins to fall as a harvester yells, "timber-r-r-r." Other workers on the site clear the way.
Close-up:
The chokerman wraps a noose around sections of the logs and attaches a cable.
Wide shot:
Oxen haul the timber off to a central collection area.
Dissolve to next scene:
Coastal harvesting site, 1989.
Action:
A harvester in jeans, plaid flannel shirt, hard hat with ear and eye protectors, and caulk boots stands on the ground using a chainsaw.
Wideshot:
The tree begins to fall and the harvester—the only one in the immediate area—moves a safe distance away, then revs up his chainsaw for the next tree.
Close-up:
The chokerman wraps chains around sections of the logs and attaches a cable.
Wideshot:
A heavy machine in the central collection area pulls the cable in, hauling the timber with it.
Fade to black.

Logs are moved to a central collection area by a grapple yarder (bottom left); in earlier days, oxen hauled the logs along skid roads (top right).



After 100 years, timber harvesters still pull on their caulk boots and work a hard, full day. But harvesting has changed a great deal. Today's harvester has the benefit of safety gear and labor-saving equipment. Felling a stand of trees doesn't take nearly as many workers as it once did. Machines have replaced animals, too. Overall, harvesting has become a faster, more efficient process, creating less waste and fewer hazards.

Technology has changed not only the way harvesting is done, but where it is done. The development of new equipment and harvesting techniques has meant that harvesters can reach new sites. They can probe further and further into the forests, and harvest higher and higher up steep slopes without degrading the soil or causing undue erosion problems.

Where, what and when

Today, more than 60 per cent of the total volume of timber harvested in B.C. each year comes from the interior. However, the coastal harvest accounts for about 55 per cent of the total value. Most of the trees are spruce, lodgepole pine and hemlock. The rest are mainly Douglas-fir, western redcedar, ponderosa pine, western larch and balsam fir. Some use is also being made of deciduous species such as aspen and alder.

Forest stands on the coast are harvested sooner than stands in the interior. The long growing season and heavy rainfall on the coast produce fast-growing trees that usually mature in 60 to 70 years (compared with 75 to 100 years in the interior). The actual length of time, of course, varies from site to site within each region.

Three main systems

Harvesting is one of the most important steps in managing a forest. It not only removes existing stands, it sets the stage for future stands. The process of tending, harvesting and replacing a forest is called a "silviculture system." Silviculture systems are classified according to the way a stand is removed and replaced. In B.C., three main systems are used:

- clearcutting (used in 80 per cent of all harvests);
- selective logging (used in 15 per cent of all harvests); and the
- seed-tree and shelter-wood systems (used in five per cent of all harvests).

When harvesters clearcut, they fell an entire forest stand. Clearcutting is the most common method of harvesting stands of trees that are the same age because the trees are ready for harvest at the same time. (Most of the forest stands in B.C. are naturally "even-aged.")

Harvesters remove mature trees of all species from a block that is about 80 hectares or less in area. If trees are damaged or infected with insects or disease, the blocks may be larger. If other resource users such as wildlife or recreationists need mature trees, the blocks may be smaller.

Selective harvesting takes mature trees from a stand that contains trees of different ages. Most selective harvesting is done in the B.C. interior. Like commercial thinning, selective harvesting opens the stand, allowing the remaining trees to receive more light, moisture and nutrients. In 10 to 20 years, some of those trees will reach maturity, and the stand can be selectively harvested again.

The seed-tree system is like clearcutting except that some strong, healthy trees are left to supply seeds for natural regeneration. The system works best with tree species that do not grow well in shade. A variation of this system, the shelterwood system, leaves more trees behind. It works better for tree species that grow well in shade. After a new stand of young trees is established, the seed trees are harvested.

The choice of one silviculture system over another depends on many things, including:

- the needs of the tree species that will grow on the harvested site;
- the nature of the ecosystem and the climate;
- the trees' age and condition;
- the needs of other users of the forest stand;
- the safety of the harvesters;
- the size and type of equipment needed to remove the timber; and,
- the costs involved.

For instance, forest managers usually clearcut stands of old growth on the coast. They prefer clearcutting over selective harvesting for several reasons. Here are some of them:

- the successful regeneration of species such as Douglas-fir calls for open ground and full sunshine;
- trees left standing would likely be knocked down by the wind, or damaged in the felling process and made vulnerable to attack from insects and disease; these trees also create a hazard for the harvesting crews; and,
- the high costs of building forest roads and moving timber from steep slopes means that companies must harvest the whole stand to make it economical.

Harvesting practices

Because the coast is so different from the interior, harvesting practices are adjusted to suit each region. They are also adjusted to suit individual sites within regions. Generally, harvesting includes the following practices:
FELLING:

Felling is the most dangerous of all harvesting practices. Further, fallers must take care to avoid damaging the trees being cut and the trees nearby. Damage can seriously reduce a tree's value.

On the coast, fallers use power saws to harvest individual trees. Forest sites are usually too steep and trees too large for tree-cutting machines. However, companies occasionally use these machines in new stands on gentle slopes.

In a seed-tree system (left), healthy trees are left standing to supply seeds for natural regeneration. Selective cutting (right) removes mature trees from a stand containing trees of varying ages.

Pre-harvest silvicultural prescriptions

A pre-harvest silvicultural prescription is a detailed plan, developed from a general plan to harvest, restock and protect a forest stand.

Forest companies prepare a prescription for each area they plan to harvest. The prescription considers the entire forest rotation—from harvest to harvest—and plans activities for the first 10 to 15 years, until the crop trees are well established and free growing.

A typical prescription includes, for example:

- how the stand will be cut;
- how the site will be prepared;
- how the site will be regenerated and with what species;
- what stand-tending practices will be necessary; and,
- what protection measures are essential.

In the interior, fallers remove large trees with power saws, but machines fell most others. Mounted on a tractor, a circular saw cuts off the trunks or a mechanical tree-shearer uses hydraulic power to snip off trees at their bases. Although the tree-shearer can fell hundreds of trees in a day, it sometimes causes splits in the wood, making processing more difficult.

Another tree-cutting machine is called the feller-buncher. It grabs a tree in two places, and cuts it off at the base. Then the same machine stacks the logs.

BUCKING:

After a tree has been cut, the faller or a "bucker" cuts off the tree top and the branches, then cuts or bucks the tree into sections. The use of the timber usually determines the length of the sections.

On some sites in the interior, trees are not bucked until they reach the mill. Forest companies may use a log processor, a machine that takes a whole tree, removes the limbs, then bucks and measures the timber automatically.

YARDING:

Trees that are felled and bucked are taken to a central collection area that harvesters call a "landing." The process is called "yarding." On the steep slopes of the coast, yarding usually involves a steel spar, mounted on a tractor. Cables extend from a large winch at the base through a pulley at the top of the spar, then to the edge of the felled timber. After chockermen fasten the logs to the cables with either chains or grapple hooks, the logs are lifted or skidded to the landing. A steel spar can pull logs to the landing from more than 300 metres away.

Recently, "grapple yarders" (similar to small cranes) have been used on the coast instead of steel spars. Rather than yarding the logs to a landing, a mobile back spar moves along the edge of the felled timber as the grapple yarder moves along the road, pulling the logs to the roadside. Although a grapple yarder cannot reach as far as most steel spars, an operator can fasten the grapple tongs to the logs without any help and without leaving the yarder. Further, the grapple yarder does not require the large crew to move it that a steel spar does.

In the interior, wheeled or crawler tractors called "skidders" often yard logs by dragging them. The machines use cables or grapples to hold the logs.

LOADING:

On coastal landings, "grapple loaders" lift logs onto trucks. Large pinchers grab a log, then swing it into position and place it on the truck. Other equipment such as cranes are also used.

Front-end loaders move logs in the B.C. interior. Depending on the size of the logs, the loaders can lift many at once. Sometimes trucks with hydraulic cranes load the logs.

HAULING:

Trucks usually haul coastal logs to a spot near an inlet, then dump them in a bundle in or near the water where they will be transported to mills. Most of the trucks stay on forest roads where they can carry very heavy loads. Often they haul 90 tonnes of timber at a time.

Trees in even-aged stands mature at the same time and are commonly clearcut (top). Logs are measured (bottom) and sorted (right).

Trucks in the interior usually transport logs directly to the mills. Where they use public highways, they haul loads about one third the size of those that coastal trucks haul.

SCALING:

The volume of wood in a load is measured by a process called scaling. Coastal logs are sometimes scaled manually; each log is measured. Others are scaled by weight, then the volume of wood is calculated.

In the interior, scaling is done by weighing each load of logs. Sample loads are selected and measured, log by log, to check the volume relative to the weight.

SORTING AND GRADING:

Logs are sorted by size and species, and graded according to how they will be used. On the coast, this is usually done before the logs are transported so that companies can take loads to appropriate mills. Sorting and grading can be done in water or on land. Boom boats can sort logs in the water, then gather them in booms. Front-end loaders are used to sort and pile logs that are moved from the site to "dryland sorts."

In the interior, most sorting and grading of logs are done at the mills.

TRANSPORTING:

While logs in the interior are usually trucked to mills, coastal logs normally travel by water. They move in:

- flat booms surrounded by logs chained together and towed (not common due to a significant loss of logs);
- bundle booms bound by wires or bands and towed (most common because less timber is lost); or
- log barges carrying huge loads and often towed long distances.

Harvesting and the environment

Harvesting has a strong impact on the environment. Visually, clearcutting reduces a lush green forest stand to a brown expanse of needles, stumps and rotten logs. If not done properly, the impact of harvesting practices can be even greater, affecting other resources or other resource users. For instance, yarding can cause serious soil erosion; and sorting and transporting can harm fish habitat.

Some harvesting systems, such as selective harvesting, remove fewer trees and have less impact than clearcutting. However, for the successful regeneration of certain tree species such as Douglas-fir, some degree of disturbance is necessary.

Harvesting and forest soils

The improper use of heavy harvesting equipment can make the soil less productive.

It can scalp or bury fertile organic and upper mineral layers, compact surface soil and expose subsoils.

Harvesting can also cause soil erosion, slumping, landslides and ground water diversions, further reducing the productivity of a forest site.

However, legislation restricts the impact that harvesting can have on soils, and forest harvesting committees are designing procedures to prevent site degradation.

Forest managers are improving harvest practices by, for example:

- making special provisions for sensitive sites;
- using low-impact yarding systems such as cable systems;
- yarding on frozen ground or snow; and,
- avoiding diversion of natural drainage channels.

Forest researchers are continually looking for ways to further improve harvesting, and they are also developing new harvesting systems.

To avoid damage to forest soils, a grapple yarder lifts logs from the harvest site to the roadside.

Helicopter harvesting

In some parts of B.C., logs are airlifted from hillsides too steep to be harvested by conventional methods. Like a giant crane in the sky, an oversized helicopter with a 60-metre cable can pick up 8 000 kilograms of logs in a single load. Then it dumps them in the water where they are taken to a mill.

Although harvesting by helicopter can reduce impact on the environment, it is expensive. Its use depends on many factors, including the location of the stand and the relative costs of road-building.

As you read further sections in this publication, you will find many examples of how harvesting can conflict with other resources and with other forest uses. You will also learn what forest managers in B.C. are doing to reduce these conflicts and, in some cases, improve other resource uses. For instance, you will see how forest managers:

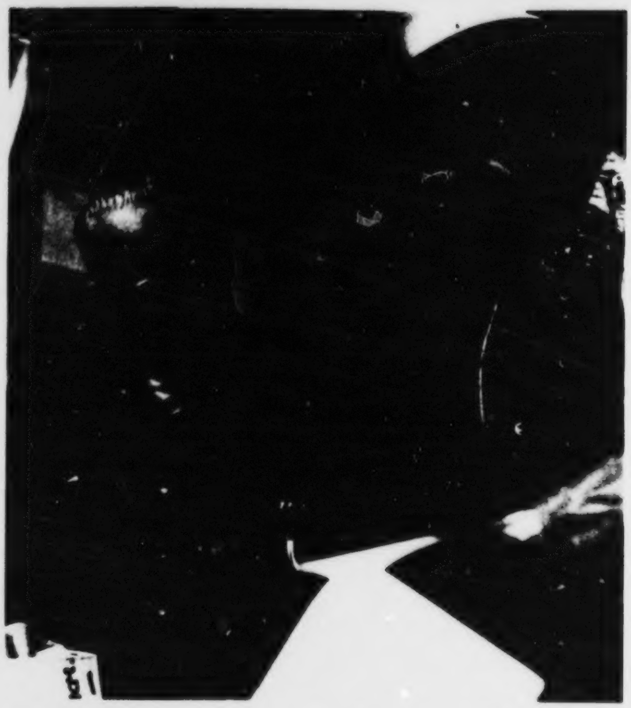
- locate, design, construct and maintain forest roads to reduce soil erosion and landslides;
- follow guidelines (which they helped develop) covering all aspects of forestry operations to protect fish habitat;
- patch cut at different elevations in the interior to increase the flow from a watershed throughout the summer;
- selectively harvest to protect winter habitat for mule deer;
- install cattle crossings on forest roads on rangeland;
- design the shape of a clearcut to blend in with the forest landscape; and
- help designate and manage wilderness areas in which no harvesting is allowed.

A new beginning

Harvesting is both an end and a beginning. By removing an old forest stand, harvesting makes way for the birth of a new stand. The speed of the stand's regeneration and the success of its growth depend heavily on the harvesting methods used to remove the previous stand. Forest managers, as much as anyone, want to see harvesting well practised and future forest stands well established.

A boom boat sorts logs, then pushes them together for transporting.

BUILDING FOREST ROADS



The construction of forest roads is planned and monitored carefully to reduce damage to the environment.

Forest engineers are the most prolific road developers in the province. Together, forest companies and the B.C. Forest Service have built an estimated 75 000 to 80 000 kilometres of roads. That's a network close to twice the total length of all highways in the province and about 10 times the length of the Trans-Canada Highway. With the harvest and renewal of more forests, that network of forest roads will continue to grow each year.

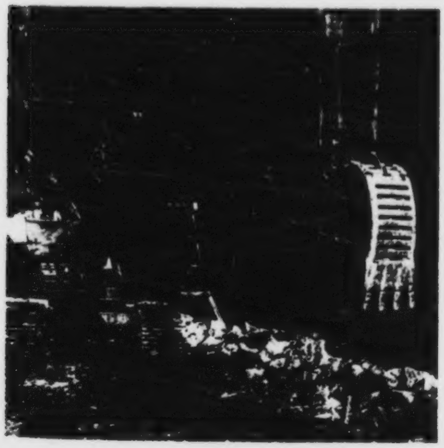
During early timber harvesting operations, oxen hauled logs short distances along skid roads. These roads were nothing more than rough trails topped with a "ladder" of logs. Sometimes skid roads were greased with fish oil so that logs could skid along more easily behind the oxen.

Today, there are three main types of forest roads:

- branch or spur roads, temporarily built and used to remove timber from particular parcels of Crown land;
- operations roads, built by forest companies to meet their needs for harvesting, planting and protection, for example; and
- main access roads, planned and built by the Forest Service (or built for the B.C. Forest Service) for long-term forest management. Some of these roads eventually become part of B.C.'s highway system.

Making forests accessible

Forest roads are essential to many forest management practices. They make it possible to reach parts of the province that are otherwise inaccessible. Trucks use the roads to haul the harvest from the forest. Forestry workers also use them to reach areas needing site preparation, tree planting and stand tending. And fire-fighters and protection crews use them to save stands from fire, insects and diseases.



Forest roads are also used by many other resource users. Mining and oil companies use the roads for exploration and development. Recreationists use them for hunting, fishing, hiking, photography, snowmobiling or simple sight-seeing. Even some wildlife, such as deer, elk and moose, find it easier to move through the forest by following the roads.

The downside

Although forest roads make stand tending and protection possible, they also reduce the amount of forest land. Once a strip of land is turned into a road, it cannot be used to grow trees. As the numbers of kilometres of roads accumulate, the total land area lost to the forest base becomes significant.

By providing public access, forest roads increase abuses, as well as uses, of forest land. For example, they facilitate poaching of wildlife by allowing irresponsible hunters into remote areas. They also increase forest fire risk from campers who set up camp away from established sites.

The improper construction and use of roads can cause serious soil erosion—even landslides. These problems arise when forest cover is removed and sub-soil is disturbed, when slopes are cut at an angle that is too steep, or when water is allowed to concentrate on or by the roads.

Roads of snow, bridges of ice

In some areas, such as the Prince George region, the land is too soft to support heavy machines; much of the harvesting must be done in the winter. When the ground freezes over, bulldozers make instant hauling roads over hard-packed snow.

Crossing a river or lake is also made easier by winter. "Roads" are built across the frozen surface—an instant ice bridge.

Poor construction of forest roads can harm fish habitat by increasing the amount of sediment in the water or blocking off spawning channels. Sometimes culverts, commonly used to build forest roads across streams, can harm fish habitat. Culverts can also create barriers to fish migration.

Roads can make an ugly gash in a landscape, and any landslides they cause can mar the beauty of a forest scene. The effect lowers the aesthetic value of the area to residents, recreationists and tourists.

Reducing the impact

Forest road engineers in B.C. recognize the problems that roads can cause. They plan roadways to minimize the amount of new construction. They try to avoid building roads where sedimentation or slope instability threatens other resources. And they try to reduce the impact of roads on the environment at all stages: location, design, construction and maintenance of roads. For example, they usually:

- locate roads away from streams, narrow canyons, slide areas and marshes (they choose locations that have stable soils and are as flat as possible);
- consider scenic values by locating roads where cuts and fills can be minimized;
- design each road according to the slopes, topography and the area's soils;
- maintain the natural courses of all streams;
- ensure that drainage channels are kept clear; clear;
- stabilize the soil on cutbanks and slopes by seeding them with grass;
- remove all culverts and bridges when forest roads are no longer required; and,
- maintain roads regularly to prevent erosion.

In the past, forest roads have caused serious damage to the environment, especially to the water resource.

Some builders haven't always taken care to avoid harming other resources. However, as B.C.'s forest road network in B.C. continues to expand each year, engineers are applying higher construction standards to protect the environment, while still providing necessary access to the forest.

Be a roads scholar

Forest roads are not built as public highways. Be aware of the hazards of driving on them.

If you have never travelled on forest roads before, check with the nearest B.C. Forest Service district office for maps and travel advice.

Here are a few safety tips.

- Yield to trucks hauling logs by moving to a turn-out. Remember—most forest roads and bridges are single lane, and logging traffic always has the right-of-way.
- Maintain a cautious speed. The limit on most forest roads is 80 kilometres per hour, but that may be too fast for your light-weight vehicle.
- Don't haul a trailer on roads that are steep, rough and tricky to maneuver.
- Drive with your lights on—day and night. Be as visible as possible.
- Beware of "sweepers"—extra-long logs on rigs. On a road with tight curves, sweepers can knock a car off the edge. On occasion, you may be asked to drive on the left side to avoid sweepers.
- Be alert for wash-outs, slides or blown-down trees. Report any road damage to the B.C. Forest Service

Careful maintenance is needed to keep forest roads safe.

MANAGING FOR FISH

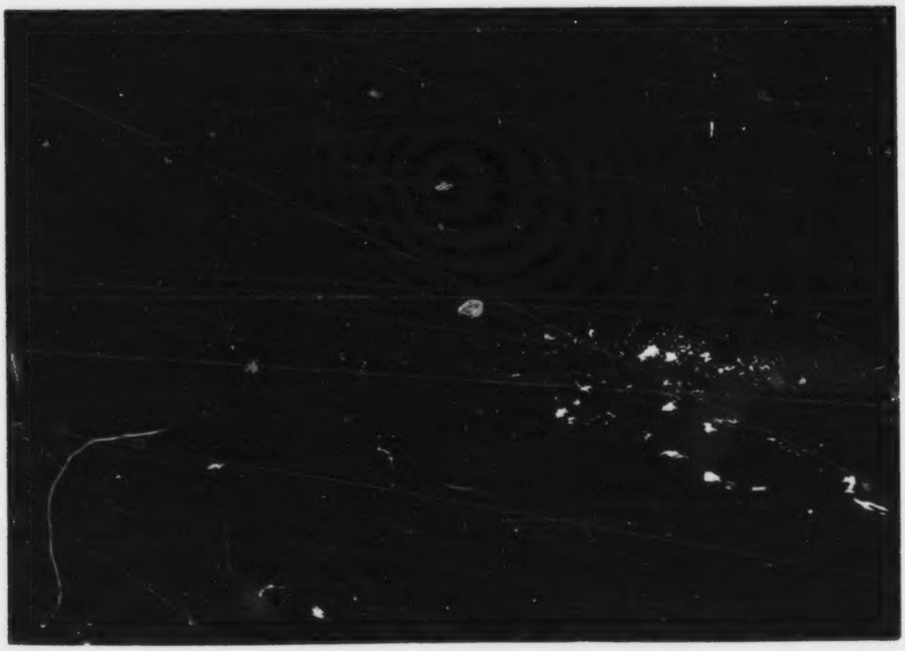
"Fish? Did you say fish?" the man asked his daughter who was talking about her field trip to a demonstration forest. "Now why would anyone need to manage a forest for fish?"

The man is not alone with his question. After all, trees grow on land and fish live in water. To many people, that makes them mutually independent. But, of course, forests and fish frequently share the same ecosystem. Therefore, what happens to the forest can affect what happens to the fish.

Consider some of the links.

- Insects on overhanging branches and on exposed tree roots along the water's edge can provide up to two-thirds of the food that fish eat.
- Trees along banks and shores provide shade in the summer, preventing high water temperatures that can harm—even kill—many fish species. In the winter, these trees also help keep the temperature from falling too low.
- Bushes and tree roots prevent soil erosion along banks and shorelines.
- Rain and melting snow can sometimes wash sediments into fish habitat. Those sediments, like eroded soil, can clog a gravel riverbed. In turn, that can reduce the oxygen exchange and the waste removal. Fish eggs can suffocate as a result.
- Trees and other vegetation affect water flow and its peaking times by intercepting rain and snow, by affecting the snowmelt rate, and, by controlling the rate of evapotranspiration, for instance.

There was a time when timber harvesters in B.C. thought much like the man mentioned at the start of this section: "Why should forests be managed for fish?" They didn't realize the damage harvesting was doing to the fisheries. But for many years now, the big question has been "How should forests be managed for fish?"



Forests and fish frequently depend on the same ecosystem (top). Trees and brush play an important role in controlling water erosion (bottom).

Fragile habitat

Fish are usually affected by any activity that changes their habitat.

Fisheries biologists are consulted on all projects involving the water in one way or another.

They can help to assess the effects of the forest projects and recommend ways to reduce the possible harm to fish.

Looking for the answers

Although there are no answers that apply to all sites, forests and fish managers have come to some general conclusions. They agree that wherever there is a fisheries resource, the water body should be protected—mainly by preserving deciduous trees and brush, and sometimes, streamside conifers as well. Valuable timber will be harvested except where it is very difficult to remove without damaging the environment.

Resource managers also agree on the conditions under which a forest company can harvest—conditions set out in a company's cutting permit. The permit can require a company to:

- avoid depositing debris in streams;
- remove any obstructions to fish movement;
- protect the river or stream from slash burning;
- build landings for logs at least 40 metres away from the stream;
- build bridges and culverts that allow for high water;
- prohibit any operations below the high-water mark; and
- prohibit timber harvesting close to banks and shores except in certain cases.

All this may sound simple and straightforward, but it's not. No two harvesting areas are the same. Each site varies according to the tree species being cut, the fish type in the water, the need for shade, the soil stability and many other factors.

Steep slopes—a major problem

The really difficult problems come into play when harvesting is planned on steep slopes. On these sites, harvesters risk causing serious damage to fish habitat through debris slides or landslides.

These concerns came to a head in 1978 when a series of major winter storms blasted the Queen Charlotte Islands. They triggered landslides over much of the forest land. Tonnes of debris swept down steep, harvested slopes into streams and onto valley flats. Damage was extensive to both fish habitat and productive forest land. Both resource managers and the public were upset.

The Carnation Creek project

Since the 1960s, the effects of forestry activities on fish habitat have been a major concern. In 1970, the Carnation Creek watershed on Vancouver Island's west coast was designated as a fish-forestry study area for research involving federal and provincial government agencies, industries and universities.

The area was carefully studied and monitored for five years prior to harvesting. Then, between 1975 and 1981, 41 per cent of the watershed was harvested using a variety of streamside treatments. The effects of these treatments were carefully assessed so that researchers could study the physical and biological changes that had occurred in the watershed.

The Carnation Creek Project has become the longest running fish-forestry study in North America. It has yielded information on such things as the critical effects that streamside vegetation has on channel stability and temperature, and the effects of herbicides on fish habitat.

The incident prompted the establishment of the Fish/Forestry Interaction Program (FFIP)—a research program involving scientists from several disciplines. Its purposes were:

- to study the extent and severity of forest-related landslides and their impacts on fish habitat and forest sites;
- to see if rehabilitation was possible;
- to find different ways to stabilize slopes; and
- to find alternate harvesting methods for steep slopes.

FFIP was funded by the B.C. Forest Service, the B.C. Ministry of Environment, and Fisheries and Oceans Canada. The Canadian Forestry Service and the Forest Engineering Institute of Canada played key roles, too. The study was unique in that it brought together all the factors affecting the interactions between fish and steep slope harvesting.

Trying to make it right

The researchers have been finding ways to rehabilitate damaged streams on the Queen Charlottes. In spawning habitat, for instance, they have used large logs and gravel-filled mesh boxes to help create stable pools and spawning beds. They have created side channels to expand the spawning areas.

Where landslide surfaces are still eroding, researchers have been seeding the area with grasses and adding fertilizer. They have also been planting trees such as Sitka spruce and Sitka alder that appear to stabilize the soil.

Because of the very heavy rains and steep slopes on the Queen Charlottes, landslides are common, natural events. However, researchers agreed that harvesting methods have increased the landslides' number and severity in areas that are marginally stable. They have been looking at many ways to improve harvesting methods—including ways to lift timber to loading areas without dragging it across the ground. They have also come up with ways to identify and map the slopes that are most likely to slide. A slope stability handbook for engineers will illustrate all the methods of identifying unstable soils and the techniques for road building on steep slopes.

Now the research into steep slope harvesting is being expanded from the Queen Charlottes onto the west coast of Vancouver Island and the mid-coast of the mainland.

More help for coastal fisheries

In another effort to help fish and forests managers, the forest industry and B.C. government resource agencies have produced *Coastal Fisheries/Forestry Guidelines.* These guidelines

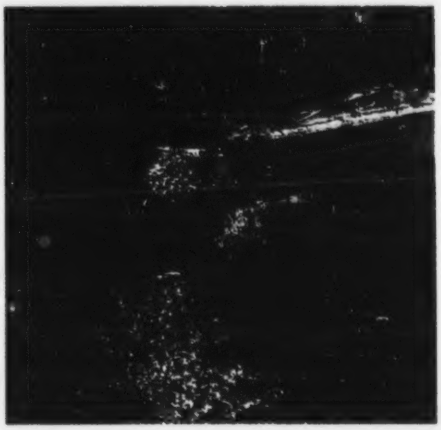
Special fishing, special attention

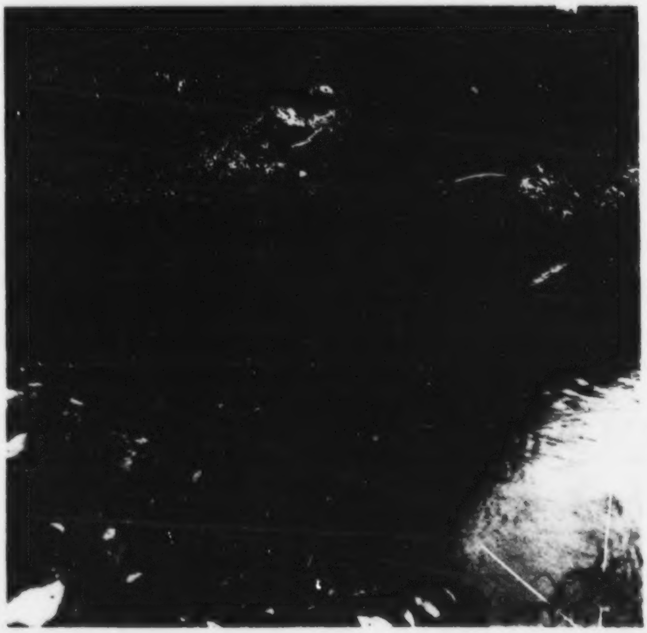
B.C. has several world-renowned sport-fishing rivers, including the Babine, a tributary of the Skeena, in the interior and the Dean, a mid-coast river.

Both are famous for their salmon and steelhead.

Harvesting operations near these rivers will require and receive careful planning and special attention.

Researchers have developed many ways to protect and rehabilitate fish habitat. They sometimes use large logs to create stable pools for fish (bottom).





River and stream banks are sometimes seeded to prevent soil erosion.

cover all aspects of forestry operations to protect fish habitat. Harvesters receive training in their use and a field book that summarizes the guidelines. All streams are classified 1 to 4, depending on their fishery use. There are very specific guidelines governing what harvesting practices and streamside protection measures are appropriate for each stream type.

Along the B.C. coast, many logs are dumped into salt water and hauled to mills in barges or booms. Bark and other debris from the logs can harm fish habitat. Fish and forest managers have been working to reduce the damage.

Many forest companies now sort logs on land—not on water—which decreases the amount of debris. They locate their log dumps in deeper water, away from the estuaries which are sensitive fish habitat. And they are making greater efforts to reduce the number of logs that "escape" from the booms and scour fish habitat.

Despite all the research and the guidelines developed for the management of fisheries and forests, resource managers still have many unanswered questions. As they come up with more of the answers, both B.C.'s fish and forest resources will benefit.

MANAGING THE WATERSHED

Watersheds are harvested using a variety of methods to protect water supplies.

No one has to tell you how important water is. About two and a half litres a day keep you alive. Together, you and your family use about 600 litres every day for cooking, cleaning, raising a garden and flushing away sewage. And of course, water is vital to agriculture and all the other industries that serve you.

Section 10 on fish management discusses how forest management practices can affect lakes and rivers that are fish habitat. These same practices can also affect watersheds that supply water to communities.

A watershed is a natural land drainage area. It may include several rivers, streams and lakes. Because most watersheds in B.C. are forested, forest management practices can affect both the quality and quantity of the water that the community receives. They can also affect the timing of peak flows and the water's movement rate. Generally, the smaller the watershed, the more significant are the effects.

Potential conflicts

Forest activities that can most affect watersheds are:

- road construction;
- timber harvesting;
- prescribed burning;
- pest and vegetation control; and
- recreation.

In varying degrees, all these activities can cause soil erosion. By increasing the amount of sediment, erosion lowers the quality of the water. Landslides are particularly destructive; they can load the water with sediment and sometimes block the flow of rivers and streams. The removal of trees on slopes can expose some watersheds to the risk of avalanches, resulting in heavy erosion.

If not controlled, other forestry activities can pollute water supplies. For instance, ash from prescribed burning and pesticides from stand-tending practices can be carried into streams. Gas and oil from forest machinery, and garbage from forest recreationists can also pollute water. Timber harvesting increases the amount of water in a watershed by increasing the amount of precipitation that reaches the ground and reducing the loss of moisture through evapotranspiration. It also influences the storage and the melting rate of the snow. Removal of trees and other plant cover can result in too much water during some seasons and not enough during others. Further, when floods alternate with drought, the water can become too laden with sediments to be used domestically.

Guarding the water supply

Section 9 on building forest roads discusses how water is protected from forest road construction. This section includes examples of how water is protected during other forest activities.

No harvesting on sensitive sites

Not all forest sites are harvested, especially within sensitive watershed areas. Examples of forested watershed sites that are excluded from harvesting include:

- a steep hillside;
- an area with unstable soils;
- a "fragile" site where regeneration may be unsuccessful;
- a site that would be impractical to reforest.

When forest managers plan a harvest, they draw up a cutting plan for the entire watershed. They consider, for example, the site's topography, its runoff features, the snow conditions and possible risks of avalanches. Then they take steps to harvest in ways that protect water quality and quantity. For instance, they:

For instance, they:

- harvest a watershed in phases;
- avoid clearing a large portion of the water-shed over a short period;
- leave stands to reduce avalanche hazards;
- use overhead methods of moving logs if the ground is vulnerable to erosion or skid logs only when the ground is snow covered;
- locate landing areas (where timber is loaded onto trucks) where runoff does not enter a stream;
- maintain buffer strips of vegetation (at least nine metres wide) along streams;
- maintain strips between cut blocks until adjacent cut blocks have grown large enough to control runoff;
- remove harvesting debris and logs in areas subject to flooding; and
- replant harvested areas immediately.

Other precautions that forest managers take to protect watersheds include prohibiting prescribed burns and pesticide applications close to waterways. If possible, equipment is stored and serviced outside watersheds. Where this is not practical, managers make special provisions to prevent oil and gas leaking from machinery.

If recreation is permitted in a watershed, signs are posted to encourage the public to practice good sanitation. Campsites and picnic spots are not allowed in small watersheds where there is limited water treatment.

Improving watersheds

By practising good forestry, forest managers can do more than protect a watershed; sometimes, they can enhance water production. This is especially true where snow is a major contributor to the water supply. For instance, harvesters in the B.C. interior can patch cut at different elevations so that flood levels are decreased in the spring. Further, after harvesting, the water flow is actually increased throughout the summer when demands are highest for both domestic and agricultural uses.

Forest managers recognize that a steady, ample supply of good-quality water is essential for British Columbians. They place high priority on both protection and enhancement of watersheds.

Forest managers can enhance - as well as protect - a watershed by harvesting patches at varying elevations and reducing spring flood levels.

Autumn had streaked the Cariboo's forests with gold and powdered them lightly with snow. On the north side of a hill, two timber harvesters from Williams Lake had been hard at work, falling Douglas-fir. As they moved around the hill, they bypassed a clump of mature Douglas-fir; they cut several spruce and lodgepole pine instead. Then one of the harvesters pointed back to the clump of Douglas-fir—to a tree with a badly broken top. He backtracked and cut it down. The other harvester took out a large tree that stood by itself.

If you had been following these harvesters you might have been puzzled by the criss-crossing pattern of their footsteps in the snow. You might have concluded that they were harvesting in a very haphazard way. But in fact, a great deal of research and planning had gone into what they were doing. Not only were they managing to harvest some valuable timber, they were taking care to protect winter habitat for mule deer. Here's what they were doing. They harvested the trees on the north-facing slope because it is seldom used by mule deer in winter. (The deer prefer the warmer, south slope.) They removed species of little value to deer on the south side of the hill but left a clump of mature Douglas-fir to give the deer shelter from cold winds and safety from people and predators. These mature trees prevent a build-up of deep snow beneath their widespread branches, creating areas where deer can move about and find food more easily. The needles and lichen-covered branches of old Douglas-fir are also sources of high-quality food.

Because old Douglas-fir are so important to mule deer, the harvesters removed a tree with a broken top before it fell off and damaged more trees in the clump. The other harvester cut the isolated Douglas-fir, which is valuable timber to him, but of little use as shelter to the deer. Further, by harvesting late in the fall, the harvesters provided mule deer with plenty of Douglas-fir needles on the downed trees—a good supply of forage for the upcoming winter.

These harvesters are just two of several hundred who have been trained in selective harvesting on mule deer winter range in the Cariboo. B.C. Forest Service researchers, with help from the B.C. Ministry of Environment, developed the harvesting method, produced a handbook for managers and a pamphlet for harvesters, and set up training sessions. The whole effort stemmed from conflicts between traditional harvesting methods and the needs of mule deer for good winter habitat.

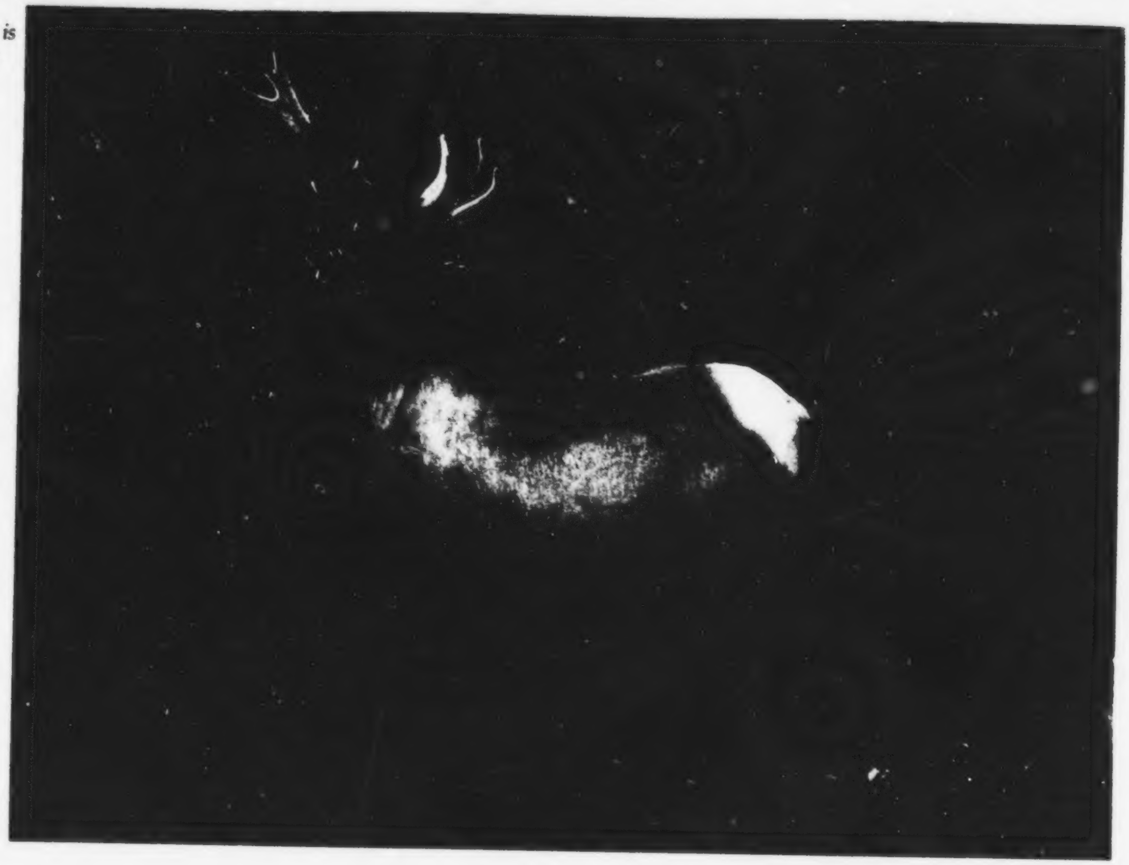
In fact, conflicts between harvesters and wildlife managers have led to the development of most integrated forest-wildlife management practices. None of the activities that affect habitat in B.C. affect it as much as harvesting. And in turn, nothing affects the wildlife itself as much as changes to habitat.

Wildlife trees

Birds such as eagles and ospreys nest in old trees . Forest managers select mature trees or snags and preserve them for these birds by posting "Wildlife Tree" signs on them.

Foresters work with wildlife managers and timber harvesters to integrate management practices.

Wildlife habitat is an important forest resource



Forests as habitat

A wide range of B.C.'s abundant wildlife (more than 600 species and sub-species of birds and mammals) live in the province's forests. All of these animals require cover, food, water and sufficient space to live. Some need special areas for breeding, and many need a winter habitat that is different from their summer habitat.

The kind and age of forest that makes good habitat varies with the wildlife. Many animals, such as grouse and moose, prefer very young, open forests. Harvesting can benefit animals like these by opening up old forests, making movement easier and encouraging the growth of fresh forage.

Other animals such as the caribou prefer very old forests. Harvesting has destroyed habitat for species that depend on old-growth stands, and in turn, harmed the wildlife that live there.

Sometimes harvesting can harm even those species that gain from the new forage that follows harvesting. For instance, the survival of wildlife is threatened when harvesting removes protective cover. Harvesting and forest roads create easy access for poachers and predators. Further, some species may leave their preferred habitat if harvesting activities come too close.

For many years, harvesters gave wildlife little or no consideration. Some valued only the timber in the forest; others acted out of ignorance, not realizing how harvesting affected wildlife.

Today, wildlife habitat management is an important part of forest management practices. Requirements for wildlife habitat are examined before any forest activity—especially harvesting—is planned.

Co-operative effort

Forest and wildlife managers work together to benefit wildlife as well as to reduce the negative impact that forestry practices have on wildlife. For instance, they may plan a harvest's timing, or change a cut block's shape or size. They may modify the way a forest is harvested, perhaps choosing selective harvesting over clearcutting. They may change the location or number of forest roads. They may even change the way a site is reforested or a stand is thinned.

Specifically, they may:

- clear a site through controlled burning and improve habitat in the process;
- thin a stand using machines instead of herbicides;
- ban harvesting of areas used by caribou when snow at high elevations is deep and soft;
- save well-placed clumps of trees for protective cover for deer; or
- preserve mature trees for eagles and ospreys.

Wildlife managers have worked with ranchers as well as forest managers to plan rangeland use. Together they have developed Coordinated Resource Management Plans for many B.C. areas. These plans cover practices such as:

- water use;
- fence placement; and
- the grazing rate.

Attaching priorities

If the conflict between wildlife use and forestry practices is very great, one resource may have to be developed at the expense of the other. When a forest is critical as wildlife habitat, it may be set aside for that sole use. In B.C., wildlife habitat is protected in many parks, recreation areas, nature conservancies, ecological reserves and bird sanctuaries. As well, in 1990 about 900 000 hectares of land have been ear-marked for wildlife, including land for its exclusive use (Wildlife Management Areas, and land purchased or leased by the Ministry of Environment) and map reserves where a strong wildlife use is respected.

Land designated for wildlife use is often improved as habitat by applying forest and range management practices. For instance, a range may be cleared, seeded and fertilized to encourage new forage. Old shrubs may be mowed down so that new browse will grow.

When a forest has a high economic value but it is not critical to a wildlife species, it may be harvested. For instance, some old-growth stands have been harvested even though they have been used as winter range for deer. And if a stand has been infested by insects, it may be harvested to control the spread of the insect—even at the expense of wildlife.

Unknown effects from intensive forestry

To complicate things further, more and more of B.C.'s forest stands are being intensively managed—that is, they are being tended much like a farmer tends a crop. The effects of this intensive management on wildlife are still relatively unknown.

Marmot reserve

The Vancouver Island marmot stays close to home—so close, in fact, that almost all of its small population live within Vancouver Island's alpine and sub-alpine regions.

That makes it a very unique mammal—one of the rarest animals in North America.

One site that had been slated for harvesting was set aside as an Ecological Reserve to protect marmots.

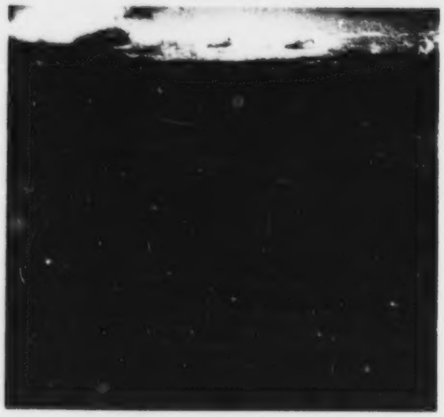
Resource managers develop integrated plans to help reduce conflict between competing resources.

Biodegradable tubes protect seedlings from grazing deer and elk (top). Timber harvesting patterns can be used to improve habitat (bottom).

The Integrated Wildlife-Intensive Forestry Research (IWIFR) program is one example of research to help managers predict the effects of intensive forest management. The program aims to create habitat in young, managed forests for deer and elk; in turn, this will release some old-growth stands currently reserved for winter habitat.

The IWIFR program is being undertaken by the forests and environment ministries, assisted by the University of B.C. and the forest industry. It focuses mainly on black-tailed deer and Roosevelt elk on Vancouver Island. It has produced many detailed findings including the following examples.

- a stand must be three metres high and at least 120 metres wide to provide hiding cover for elk; and
- thinning young stands to 500 trees per hectare produces forage, for at leat 10 years, in amounts many times greater than those in unspaced stands;



The outcome of much of the wildlife/forestry research is a collection of handbooks, guidelines and computer programs to help managers develop better and better plans. As so much habitat is also used for other purposes, these plans are critical in ensuring the future of B.C.'s wildlife.

MANAGING THE RANGE

You're following a dirt trail through the woods when you come across a scattered herd of cattle grazing in a field of grass and clover. Surprised, you look about, half expecting to see a building or some other sign of farm life. There is none.

The area you have discovered is actually a forest site. It has recently been harvested, then seeded with grasses and legumes. The seeding stabilizes the soil, rehabilitates skid trails, and provides forage for domestic livestock and wildlife.

If you are like most British Columbians, you were surprised to find a herd of cows in the woods. People usually think of rangelands as rolling expanses of prairie grasslands. In B.C. however, rangelands are more often temporary openings in the forest caused by fire or harvesting, or sparsely timbered forest lands where grass grows among stately yellow pines. In fact, more than 80 per cent of all Crown land grazed by domestic livestock in B.C. is forested.

Home on the range

Domestic livestock have used B.C.'s rangelands since the mid-1800s. The Gold Rush was responsible for the main influx of livestock; then the building of the Canadian Pacific Railroad caused their numbers to grow.

Early ranchers grazed their cattle, sheep and horses on the province's open grasslands. As the number and size of herds increased, they found forage in alpine areas and in open forests. Then timber harvesters began cutting areas adjacent to ranches and building roads to other cutblocks. The ranchers took the opportunity to expand the grazing area for their livestock and to use clearcuts or burnt areas seeded with grass to supplement forage supplies.

In B.C., ranchers graze their livestock on both private and Crown lands. They get permits and leases to use specific areas of Crown land.

Cattle may graze on low-elevation, private pasture land for about two months in the early spring; then as that grass begins to dry up, they may move to the forested Crown land and graze among the trees. By late summer, cattle must cover a large area to get enough food. For instance, in dense stands of lodgepole pine and balsam, up to 40 hectares are needed to support one cow and her calf during August and September.

Locking horns

In the early days, the grazing of livestock occurred with little concern over it effects on other resources. However, as the population grew and the use of natural resources expanded, ranchers came into conflict with forest and wildlife managers and outdoor recreationists.

More than 80 per cent of all B.C. Crown land grazed by domestic livestock is forested. Moving livestock helps protect the range resource (top).

Grazing helps trees grow

Over several years, researchers studied cattle that were grazing sections of a lodgepole pine/Engelmann spruce plantation in southern B.C.

The grazing reduced the trees competition from other plants growing on the site. It directly improved the stand's growth.

For instance, forest managers worried that seeding grass in clearcuts might reduce the productivity of a new forest. Wildlife managers saw domestic livestock competing for food with wild animals such as deer and elk, and disturbing nesting waterfowl at watering ponds. Recreationists didn't appreciate the restrictions of the rancher's fences.

Further, provincial policies to fight most natural fires allowed the forest to encroach on areas of grassland decreasing forage for both wildlife and domestic livestock.

Ranchers and wildlife managers became upset with timber harvesters over rights-of-way through pastures.

Off-road recreation vehicles, such as trail bikes and four-wheel drives, frightened both domestic livestock and wildlife, eroded soil and spread weeds from one part of the range to another.

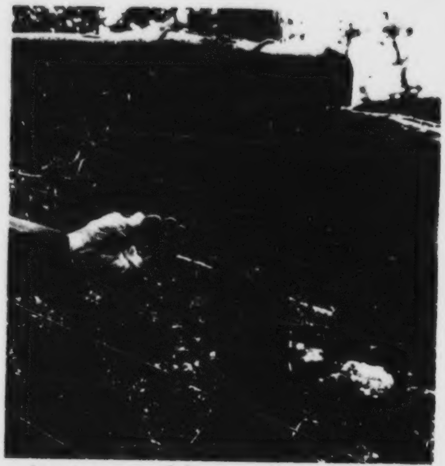
All things considered

One effective way of resolving conflicts over the use of rangelands has been through Coordinated Resource Management Plans (CRMPs). These plans are developed jointly and reviewed annually by resource managers, resource users and land owners. The purpose of CRMPs is to:

- find ways to make different resource uses compatible;
- improve or maintain the resources; and
- maintain goods, services and other benefits from rangelands while protecting the environment.

For instance, outdoor recreation groups have worked with resource managers to curb the use of off-road vehicles in sensitive areas.

Resource managers have worked together to protect watersheds by keeping animals from using streams and discouraging overgrazing that contributes to erosion and rapid runoff.

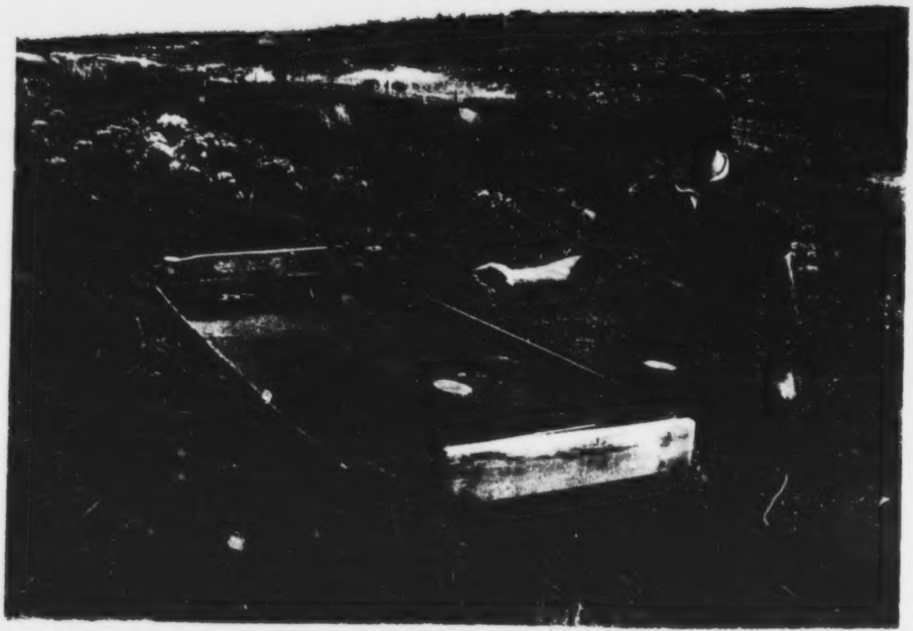


Conflicts between domestic livestock and wildlife have been reduced in some areas by scheduling the grazing of cattle very early in the summer, then moving them before they eat the browse needed by deer in the fall. Further, cattle have been kept from grazing in critical elk habitat or from watering at ponds used by waterfowl for nesting.

In some ways, timber harvesting is compatible with both ranching and wildlife management. By clearing forest stands, the harvesters create an abundant supply of forage; in turn, the grazing of dry grasses and shrubs reduces the risks of forest fires and helps control competing vegetation in young plantations.

However, there are many conflicts which CRMPs address. For instance, although logging roads provide both wildlife and cattle access to new supplies of forage in previously ungrazed areas, they make it difficult for ranchers to control the movement of cattle. Timber harvesters

Rangeland are improved by building fences to control grazing (top), increasing the number of water sources (bottom) and seeding harvested areas with grass (opposite)



and ranchers can reduce this problem by installing cattle guards. Where forest roads might disturb cattle or wildlife, forest companies may locate roads away from prime grazing areas.

In some areas, forest managers are unhappy about the seeding of clearcuts with grass; however, in young plantations of lodgepole pine, the growth of trees has been compatible with grazing by both wildlife and domestic livestock.

Improving rangelands

Range managers try to support as many grazing animals as possible without damaging the range. That means they are constantly working to enhance and improve grazing areas. Some of their methods are described here.

- Seeding
  Rangelands can be artificially seeded to increase forage, to avoid soil erosion and to prevent weeds from taking over a site. A mix of seeds taken from early-maturing and late-maturing species can help extend the grazing season.
- Fertilizing
  Applications of fertilizer can increase the volume of forage. It can also increase protein content and palatability.
- Developing water sources
  Limited drinking water restricts the movement and distribution of grazing animals. On level rangelands, cattle should not walk more than 1.5 kilometres from forage to water—less on steeper sites. Ranchers try to

Knapweed: foreign enemy

Two species of knapweed, the spotted and diffuse, are the worst rangeland weeds in B.C.

Native to the Balkans, Russia and Asia Minor, knapweed entered Canada before the 1930s in a shipment of alfalfa seed.

In B.C., no local animals feed on knapweed; no diseases attack it.

Once knapweed moves into an area, it takes over. It has spread through 85 000 hectares of B.C.'s southern interior. Range managers have been working to check the spread of knapweed. They have also tried to kill it off.

One of the most promising control methods has been the introduction of insects that attack knapweed.

The biological control program was initiated in B.C. in 1961.

Four insects, carefully screened then released in the province, are now established and their populations are spreading. They affect the reproduction and the natural vigor of knapweed.

As the insect populations increase, they are expected to provide an effective control.

conserve existing water supplies for their livestock. They may also need to make ground water available, or haul or pipe water to the fields. In some areas, ranchers create dugouts to catch the rain or reservoirs to store water from streams and runoff.

- Fencing

  Fences control the movement of grazing animals to ensure an even use of forage and good growth of animals.
- Controlling Rodents

  The burrowing of rodents, such as gophers and ground squirrels, can improve rangelands by mixing the soil; their excrement and food caches are sources of fertilizer. However, rodents can also destroy root crowns and stem bases of plants, eat large amounts of forage, worsen the effects of drought by tunnelling, and increase soil erosion. Trapping and gassing are effective methods of control for limited infestations; other mechanical and chemical methods are used for widespread problems.
- Controlling Weeds

  Weeds can be a serious problem on rangelands. They compete with forage plants for soil, moisture and nutrients. Range managers try to avoid the problems or weeds in the first place through good range managment. However, they also have to check infestations by using chemical or biological controls.

Managing rangelands is not unlike managing forest land. Decisions to improve or develop the land and its resources must recognize the needs of all resource users.

By working together, resource managers not only reduce conflict, they manage their collective resources more effectively.

Knapweed is the worst rangeland weed in B.C. (top and bottom). Insects are used in a biological control program to attack it (bottom).

During the 1860s, thousands of cheering prospectors followed the rocky road from Quesnelmouth (now Quesnel) to Barkerville, searching for gold. Despite the tough travelling—by foot, horse and stagecoach—they were awed by the rugged, green beauty of the area and the cool, crystal of its rivers and streams.

Today about 150,000 non-local tourists travel much the same route—Highway 26—every year. Many of them go to "return" to the 1860s at the re-created mining town of Barkerville. Outdoor recreationists also enjoy the area for skiing, hunting and fishing.

FOREST LANDSCAPE HANDBOOK

It was not surprising, then, that the townspeople of Quesnel and Wells (a town near Barkerville) became concerned that the forest along the highway was slated for harvest. They felt that timber harvesting would seriously detract from the area's wilderness character and historical nature. They also worried that it might decrease the number of tourist dollars spent in their towns.

In the fall of 1987, the people gathered to discuss their concerns. Forest companies explained that they wanted to harvest an average of about 100 hectares each year over the next 20 years. Further, the strong winds in the area meant they would have to cut in large blocks. (Exposed trees would be easily blown down.) But the companies promised to practice forest landscape management—to blend harvested areas with the natural landscape.

Even though the townspeople recognized the importance of the forest industry to their local economy, they were against any harvesting that could be seen from the highway. Most stood firm until it was pointed out that—with proper landscape management—none of the harvested sites would be as obvious as the area's existing ski-run. It is visible from the highway for more than a kilometre.

From that point on, the discussion no longer focused on if the area should be harvested, but how.

More and more frequently, the techniques of forest landscape management are helping to resolve conflicts between harvesting the forest and preserving its beauty. In each case, the forest manager's job is to study the landscape, learn how it is viewed, and plan forest activities in a way that is acceptable to residents and tourists. Here's how it works.

Taking inventory

First forest managers take an inventory of the landscape and map it. They:

- plot the boundary of the visible landscape on a map showing the landscape as it appears from travel routes, communities and well-used areas, such as parks, ski hills and viewpoints;
- mark specific viewpoints, and special features, such as waterfalls, historic sites, farmlands, orchards and settlements; and
- indicate the relative importance of the landscape features and how the landscape is viewed (how many people see it—from what distance and angle, and for how long).

What is a landscape

There are many different kinds of landscapes. Some are large with wide-sweeping views of mountains and lakes, or meandering rivers; others are small and brimming with detail like coastal ferns or pebbly beaches. Sometimes a single feature such as a waterfall dominates a landscape; sometimes several features are equally important.

Landscapes include color, texture, form (three-dimensional mass) or shape (a two-dimensional background scene), and line (a one-dimensional silhouette—like a ridgeline or a shoreline). Line is the major element in most B.C. landscapes. Fortunately, it is the element that managers can manipulate most effectively.

Landscape managers plan the shape and size of cutblocks to help blend harvested areas with the natural landscape.

Forest recreational activities in B.C.

Tourists and residents enjoy recreation in or near B.C. forest land all year around. The type of recreation they enjoy varies widely, ranging from a back-to-nature wilderness experience to a close-to-home, highly developed form of recreation. Here is a list of some of their forest recreation activities.

- Viewing the forest land from:
  - ■ viewpoints
  - ■ highways
  - ■ back roads
  - ■ logging roads
- Trail riding by:
  - ■ horse
  - ■ bike
  - ■ four-wheel drive
  - ■ snowmobile
- Skiing:
  - ■ downhill
  - ■ cross-country
- Snowshoeing
- Collecting
- Orienteering
- Hiking
- Rock climbing
- Caving
- Camping
- Picnicking
- Canoeing
- Kayaking
- River-rafting
- Boating
- Fishing
- Hunting
- Photographing
- Birding
- Swimming
- Diving
- Water skiing

Using computer programs, forest planners can lay out roads and design cutblocks to see how they would look from various view points.

Road building is kept to a minimum, especially on steep slopes (opposite).

Analyzing the landscape

If proposed harvesting falls within the visible landscape, forest managers draw up more detailed maps. They set "Visual Quality Objectives," that is, objectives based on things such as the area's attractiveness, or the importance or uniqueness of its special qualities. Then managers weigh these objectives against considerations such as:

- ■ the economic value of harvesting relative to tourism;
- ■ the numbers of people who will see the landscape and their attitudes towards it; and
- ■ the ability of the landscape to absorb or hide changes.

Forest managers may then make a decision not to harvest any visible stands, or they may decide that harvesting in certain areas can be designed to harmonize with the environment.

Planning a design and layout

If harvesting is planned, forest managers use computer programs to design and lay out roads and cutblocks. The programs produce three-dimensional images of the landscape. Managers can "see" how different designs and layouts would look. They pick out the dominant elements in the landscape and try to match or blend roads and cutblocks with them.

Managers have to take into account the ability of the landscape to absorb or hide changes. For instance, changes to gentle slopes are harder to see than changes to steep slopes. Trees can screen some changes from view. Natural openings blend well with harvested areas. Distant landscapes reveal less change than ones up close. A variety of landforms absorb change as do darker soils. Because they green up more rapidly and have more shade, north slopes also absorb more change. Existing man-made alterations such as roads, railways, powerlines and patterns caused by harvesting absorb further change.

The managers select the most appropriate design for each area. Then the computer program calculates the harvesting costs and timber values of each design.

Choosing suitable forestry practices

When they harvest a visible landscape, forest managers may use practices that reduce the negative visual effects of harvesting. For instance, they may:

- minimize road building, especially on steep areas where cable or aerial harvesting may be used;
- locate harvesting roads on stable ground;
- remove excessive road-building material;
- remove debris along roadsides and in harvesting areas;
- harvest in the winter when forest sites can be reached without major road development;
- remove damaged or poor quality trees;
- harvest efficiently, avoiding high stumps;
- seed roads and landings to grass; and
- plant or induce early natural growth to green up the area quickly.

Managing forest recreation

Keeping B.C. beautiful is a very important part of managing the forest for recreation. It affects the quality of all forest recreational activities. However, besides landscape management, forest managers work along other lines to create recreational opportunities and to protect the recreational resource.

For instance, they manage roads, trails and recreation sites all marked on maps available from forest companies and the B.C. Forest Service. Both the industry and the B.C. Forest Service provide rustic campsites with very basic facilities usually in the more remote areas, or in the most heavily used Crown forest land. On long routes requiring several days hiking or cross-country skiing, campsites may include a rough shelter.

Forest managers provide these basic campsites to:

- respond to public interest in outdoor recreation;
- create peaceful, in-tune-with-nature spots for over-nighting;
- reduce crowding and damage to the environment;
- reduce risks to public health from accumulated wastes;
- reduce risks of injury from natural causes such as the wind blowing down an old tree; and
- reduce the risks of fire caused by recreationists.

Planning the recreation resource

In planning for forest recreation, forest managers must keep current with the trends. Over the last several years, they have been aware of an increase in canoeing, hiking and cross-country skiing—and especially in adventure sports like kayaking and rock-climbing. Managers have responded by integrating their facilities with networks of trails and strings of lakes—like the 48-kilometre canoeing route in the Sayward Forest on Vancouver Island.

Forest managers concentrate on providing opportunities for what they call "dispersed

Forest recreation facilities and their use

Forest trails: about 8 000 kilometres established by the B.C. Forest Service and managed co-operatively with outdoor clubs, forest companies and others; they receive about 410,000 users during a year (1987-88).

Forest camping and picnic sites: 1,180 sites established and managed by the B.C. Forest Service and forest companies; they, receive about 1.5 million recreation user-days during a year (1987-88).

Forest recreation facilities include sites for people with special needs. These recreationists are enjoying the Inland Lake Trail near Powell River.

Conserving the Grease Trail

The Alexander Mackenzie Grease Trail was a trade route used by Indians in the interior of B.C. for thousands of years. They followed it every year to the coast to trade for ooligan oil—a cooking oil obtained from the ooligan or candlefish. During his explorations, Alexander Mackenzie followed the Grease Trail to the coast. Today that trail is protected under the *Heritage Conservation Act* and maintained by the B.C. Forest Service.

recreation," that is, any activity that takes people wandering over the landscape. Forest managers in government and in industry are responsible for recreation activities—not in parks—but on any of the 80 million hectares of non-committed public land in B.C.

The B.C. Forest Service recently completed an inventory that classifies all Crown land according to its recreational values. For instance, some land, like the Grease Trail (see sidebar), has historical value; other areas are valued primarily for their water bodies, their landforms, or their wildlife. (There is hardly a hectare that has no recreational opportunities.) The inventory also assesses the sensitivity of each area to harvesting and other forest management practices.

Because recreation management is part of forest management, any forestry decision is also a recreation decision. When forest managers draw up their forest management plans, they consider recreation goals along with goals for timber and range management. They look at the information provided in the recreation inventory and the data about current recreation use.

If any forestry practice, such as harvesting, threatens the value of recreation, forest managers may decide to leave certain hectares solely for recreation. They may adopt certain practices, such as the landscape management you have already read about, to accommodate recreation needs. Or they may improve recreation opportunities by thinning a crowded forest and opening it up to wildlife and camping.

The foundation for forest recreation is the same as the foundation for all forest uses—a healthy forest environment. By working to improve opportunities for the public to enjoy B.C. forests, managers are also working to improve the resource.

By creating recreation sites and trails, forest managers increase the public's use and enjoyment of the forest.

First provincial forest wilderness area

The first wilderness area in provincial forest land was officially designated in 1987.

The Height-of-the-Rockies Wilderness Area covers 68 000 hectares along the west side of the Continental Divide between Kootenay National Park and Elk Lake Provincial Park.

The local residents requested the wilderness designation to preserve the area's magnificent mountain scenery and its rich variety of wildlife, including elk, bear, deer and bighorn sheep.

It's mid-summer. Blossoms splash the sky-high meadow with yellow, red, white and mauve. Among the blooms grazes a bighorn sheep, a solitary figure standing before a dramatic backdrop of glacier-capped mountains.

Into this scene step two hikers. They slip off their backpacks and rest against a rock. The peace and beauty of the alpine seem a world away from the busy city where they live. Here above the treeline, the hikers feel free and at one with nature.

Moments like this draw people from their everyday urban environment into the wilderness. They need to "get away from it all" occasionally—to escape from the half percent of the province's land area where most British Columbians live.

B.C. has many wilderness lands, mainly in the north. In fact, almost half the province is wilderness—remote, undeveloped tracts of land. Some areas are alpine; others are rugged fjords. Some are gentle valleys; others are wide expanses of forest.

The people of B.C. recognize many wildlands as an important part of their natural heritage. Wilderness is valued for its ecosystems and its landscapes. It attracts recreationists, adventurists, tourists and researchers.

Responsibility for wilderness in Provincial Forests

The B.C. Forest Service has had a longstanding, implicit responsibility to manage wilderness in Provincial Forests. Recently, legislation made that responsibility explicit. (The Ministry of Parks is responsible for wilderness in provincial parks and recreation areas.)

But the idea of managing wilderness sounds contradictory. Why try to manage something that is, by nature, wild and free?

If B.C. is going to preserve some of its wilderness, the impact of human use must be minimized in some areas—and that's where management comes in.

With its new (1987) wilderness mandate, the B.C. Forest Service prepared a paper for public review. The paper suggests how designated wilderness areas might be planned and managed. The comments received will guide the formulation of an official wilderness policy. In the meantime, the B.C. Forest Service is managing wilderness in provincial forests according to its draft framework and policies.

Areas like the Height-of-the-Rockies preserve the wilderness resource and provide opportunities for a wilderness experience.

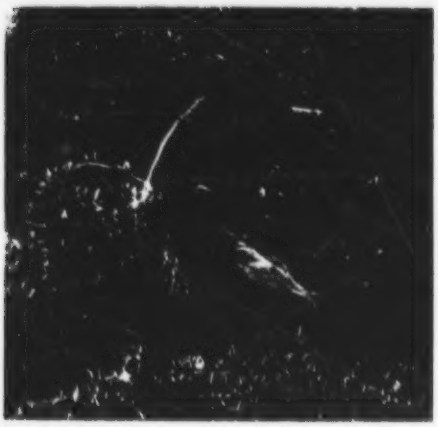
The purpose of the wilderness program is to maintain a wilderness resource, and provide British Columbians and visitors the opportunity to enjoy a wilderness experience. As a basis for doing this, forest managers will be assessing the demand for wilderness. They are also trying to determine the impact of recreational and industrial uses on wilderness.

As well, forest managers are developing an inventory of areas potentially capable of providing wilderness experiences. It includes two main classes:

- primitive—natural areas larger than 5 000 hectares and more than eight kilometres from the nearest road; and
- semi-primitive—natural areas larger than 1 000 hectares and more than one kilometre from the nearest road.

Ten-step process

The B.C. Forest Service is proposing to use a 10-step process to designate and manage wilderness areas in provincial forests:



1. Draft terms of reference after consulting with relevant agencies.
2. Seek public opinion and prepare terms of reference.
3. Identify and take an inventory of resource values.
4. Assess and compare the resource values.
5. Prepare a land use option report and distribute it for public review.
6. Forward recommendations to the Cabinet.
7. Request a Cabinet decision regarding the wilderness designation.
8. Prepare a wilderness management plan.
9. Implement, enforce and monitor the plan.
10. Revise plan as required every five years or sooner.

Resources within wilderness areas

Under legislation, mineral, gas and oil exploration and development are allowed in wilderness areas. However, the B.C. Forest Service works with the Ministry of Energy, Mines and Petroleum Resources to control the way mining activities alter the landscape. For instance, guidelines established for mineral exploration aim to reduce environmental impact.

Commercial timber harvesting is prohibited by law in designated wilderness areas, but trees may be cut for other reasons such as safety and trail-clearing.

Fishing, hunting and trapping are traditional wilderness activities that are allowed subject to provincial fish and wildlife regulations. Existing traplines may be continued.

The B.C. Forest Service co-operates with the Ministry of Environment which manages fish and wildlife resources. Together they allow modification to fish and wildlife habitat and populations that are intended to emulate natural processes.

To fight or not to fight

People value wilderness for its naturalness.

Wildfires and outbreaks of insects and disease are natural. However, they may damage other wilderness values, such as the beauty of a forest, or they may spread to areas nearby.

Whether or not fire and pests are fought usually depends on the unique conditions in each wilderness area.

A fire and pest management strategy is established as part of each wilderness management plan.

Trees killed by fires, insects, diseases or wind may be salvaged if they threaten the safety of the public or adjacent commercial forests.

Wilderness areas contain some range land. Traditionally, ranchers, guides and outfitters have leased grazing land for cattle, sheep and horses. Commercial grazing of cattle and sheep, and recreational use and grazing of horses may exist in designated wilderness areas where they are consistent with the wilderness management plan.

Access and recreation in wilderness areas

Managing access in a wilderness area is critical to the management of the wilderness area. Public roads are prohibited. Mining roads are closed to the public, and they are reclaimed when a mining operation ends. Unless permitted in a wilderness management plan, public use of motorized vehicles is prohibited.

Wilderness may be used for both commercial and public forms of recreation, but some forms of recreation conflict with others. In general, commercial and public recreation in designated wilderness areas may be allowed if:

- it is compatible with the wilderness;
- established uses are recognized and any conflicts are minimized (conflicting uses may be separated by area, season or time of day);
- it is provided for in the wilderness management plan; and
- facilities are limited.

Managing wilderness means conserving the natural environment and fish and wildlife populations.

In wilderness is conservation

In managing the wilderness, forest managers are conserving more than the natural heritage of B.C.; they are conserving natural environments and the fish and wildlife populations that are valued by all people. For as Thoreau said, "In wilderness is the preservation of the world."

MANAGING THE TIMBER SUPPLY

It's hard to think of resources that don't need any management. Soil needs replenishing. Water needs conserving. Even resources that are self-renewing and seemingly endless in supply, such as fish and timber, need protecting.

In B.C., the management of all resources, including timber, has been evolving since the early 1800s. In those days, lumber production needed only to meet local demands. That was easy. Then mills began processing timber for export and the demand increased.

Ensuring a continuous supply

In 1945, the B.C. Forest Service took steps to ensure a continuous timber supply—it made "sustained yield" an objective. That meant forest companies could harvest only the amount of timber that could be replaced by the annual growth of the forest—plus a portion of B.C.'s many old-growth forest stands.

As part of its management strategy, the B.C. Forest Service began to encourage the harvest of old forest stands. Companies started replacing these slow-growing—sometimes decaying—stands with fast-growing, young stands that produce greater volumes of wood over time.

Forest managers realized that once the old-growth stands were cut, harvests would depend solely on the annual growth of the forest. They began working to improve this annual growth to minimize the impact of the loss of old-growth harvests.

In 1979, forest managers did an analysis to determine the potential of forest land to meet the demands for timber. They concluded that B.C. should:

- increase the harvest of less desirable species of trees;
- harvest sites that are considered less accessible;
- further improve silvicultural and harvesting practices;
- use wood more efficiently; and
- protect the forest land base.

As a result, forest managers expanded their silvicultural programs and improved the efficiency of timber harvesting--holding their rate of cut constant.

The economy of many small towns in B.C. is driven by forestry.

The aging forest

The merchantable volume of timber in a forest stand varies with age. During immature stages, the volume increases rapidly. After maturity, the rate of growth slows as trees lose their natural vigor.

In time, decay overtakes their growth and the volume of timber begins to decline. The trees become especially vulnerable to fire, insects and diseases.

However, some old forests are left as a bench mark for ecological succession. They also provide genetic diversity, habitat for some wildlife species and a wilderness experience for people.

Old-growth forests eventually become "climax forests," the final stage of natural forest succession. The old trees gradually die off and are replaced by young trees—species that can grow in shade.

The climax forest consists of a mix of very old, young and middle-aged trees.

Today, they are working to further increase the volume of the wood from vigorous, new forests by:

- preparing and maintaining good planting sites;
- planting genetically superior seedlings that are well-suited to the ecosystem; and
- weeding, thinning, fertilizing and pruning young stands.

Improvements in these practices will make major changes to the long-term timber supply, even expanding the land's natural ability to produce trees.

This fact becomes increasingly important as more and more forest land is removed from timber production for uses such as transmission lines, water reservoirs, highways, farms, urban expansions, parks and wildlife habitat.

Forest managers are also making more efficient use of the current wood supply by:

- using a wider range of tree species (including hardwoods such as aspen);
- using more of the decadent cedar-hemlock stands;
- using more of each individual tree;
- improving protection of stands from fire, insects and diseases;
- refining harvesting operations such as falling and bucking to reduce waste; and
- using advanced sawing and planing techniques in sawmills to increase the value of the logs.

Changes such as these make a difference even on the short-term. For example, a greater use of aspen is increasing the wood supply in the Fort St. John/Dawson Creek area.

Where possible, forest researchers are increasing the accessibility of some forest stands by improving the technology needed to:

- extract timber on sensitive sites without harming other resources; and,
- reduce the costs of building roads to remote sites or of using alternate means of transporting logs.

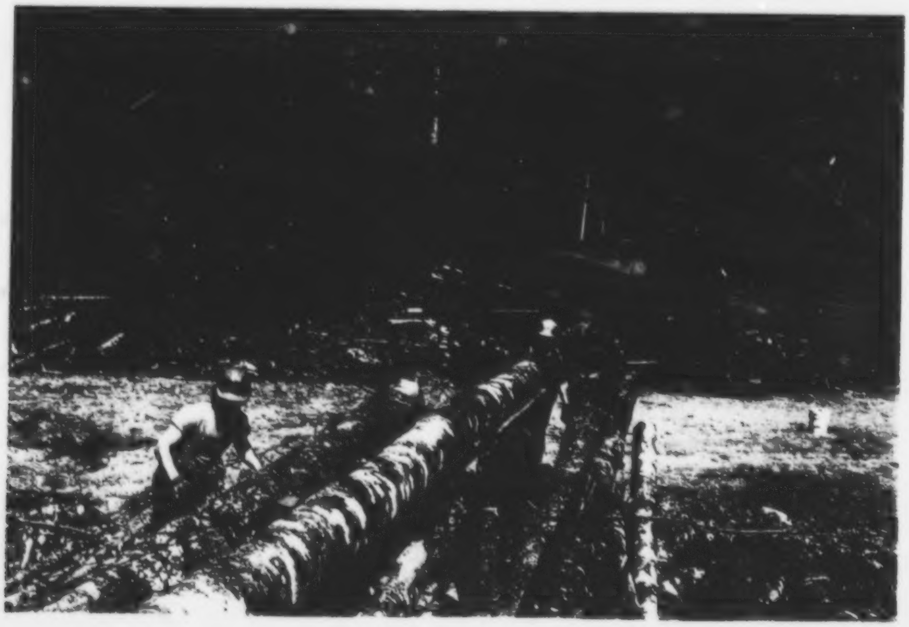
Forest management units in B.C.

B.C.'s Crown land is divided into a number of forest management units called Timber Supply Areas (TSAs) and Tree Farm Licences (TFLs). The B.C. Forest Service grants rights—in the form of tenures, or licences—to individuals and companies to harvest and manage the forest stands in these units.

In a TFL, the holder of a licence manages and harvests forest stands on specified areas of Crown land. Most other forms of tenure are based on the volume of timber that can be harvested each year from a TSA.

B.C.'s policy of sustained yield is administered through TFLs and TSAs. Tenure holders must operate according to standards set by the B.C. Forest Service and harvest

Innovative forest management, improved technology and modern mills make B.C. forest products competitive worldwide.



Restocking NSR lands

Foresters have not always known how to treat burnt or harvested sites adequately; therefore, some potentially productive forest land in B.C. is growing trees and other plants of little or no commercial value. They are sites that have not properly regenerated, either naturally or following planting. Forest managers call these areas NSR (Not Satisfactorily Restocked) lands.

Since 1985, forest managers have been making an intensive effort, as part of a federal-provincial program, to establish healthy stands on NSR land throughout B.C. The area of NSR is being substantially reduced through work under this program.

Many not-satisfactorily-restocked sites are overgrown with vegetation of little or no commercial value (right).

In B.C., the amount of timber harvested on Crown land is regulated by the Forest Service.

according to an allowable annual cut (AAC) set by the chief forester.

In setting the AAC for each TSA and TFL, the chief forester considers:

- the rate of timber production that the area may sustain, taking into account factors such as:
  1. the composition of the forest and its expected rate of growth;
  2. the amount of time the forest will need to re-establish;
  3. the silvicultural treatments to be applied;
  4. the standard for timber use and allowance for decay, waste and breakage; and
  5. the need of other resource uses in the area;
- the short- and long-term implications to B.C. of alternative rates of harvest;
- the needs and nature of timber processing facilities;
- abnormal infestations of insects or diseases, fire devastations and major salvage programs planned for timber on the area; and
- a wide range of environmental, social and economic factors.

AACs are set for a five-year period, but the rate of harvest can be averaged over those years. Depending on conditions ranging from insect infestations to market values, more trees may be harvested in some years than in others. Over the five-year period, the average is consistent with the AAC.

AACs are reviewed every five years. They are adjusted to reflect changing conditions such as improved use of wood, expanded silviculture programs, and better protection from fire and diseases.

Information to count on

Before forest managers make decisions about the timber supply, they turn to the comprehensive forest inventories that they maintain. A forest inventory provides general information about forest land in B.C. It also provides detailed information about forest sites and stands, including data such as:

- the composition of tree species;
- the age classes;
- the height classes;
- the number of trees per hectare;
- the amount of ground covered by the canopy of trees;
- the history of a stand, that is, if it has been burnt, logged or reforested;
- the productivity of the growing site;
- the ecological classification;
- the environmental sensitivity of a site, for example, its susceptibility to avalanches, and the degree to which its disturbance would adversely affect resources such as soil, fish, wildlife and watersheds; and,
- inoperable problem areas—inaccessible areas in terms of current harvesting technology.

As well, forest managers maintain inventories of a variety of resources and resource uses such as recreation and range. This information can be combined with inventories (such as fish and wildlife populations) maintained by managers in other resource agencies.

Taking inventory

Because of the large amounts of data needed to manage the forests, many specialists are involved in taking and updating the inventory. They take information from several sources. For instance, forest inventory crews collect data from sample plots of land. Forest managers also obtain data from aerial photographs and satellite imagery.

Of course, forests are constantly growing and changing. Therefore, forest managers maintain a continuous inventory, that is, they continually update and enhance the data on the forest resource. Forest district staff help with the updating by recording and reporting changes to forest land, noting areas that are diseased, harvested or replanted, for example.

Using inventory data

Resource managers use forest inventories to help plan both present and future forest management activities. They analyze the information through computer systems that display inventory data in the form of statistics, drawings and maps.

By using a computer mapping system, called a geographic information system, resource managers can study vast areas of B.C.'s forest land at once or focus in on a single hectare. They combine information on the forest with other data such as wildlife habitat and soil stability to help develop integrated, environmentally sound forest-use plans.

Sometimes forest managers use the data from the geographic information system in three-dimensional form. For instance, they display three-dimensional images of a forest landscape to "see" how different designs and layouts of roads and cutblocks would look.

Forest managers also use computers to calculate the volume of timber for each tree species. They account for losses of volume due to wood that can't be used, such as small logs and branches, rot, breakage, tops and stumps. The net volumes for each species are used to calculate the total usable volume of timber for each stand.

Before forest managers decide how much timber can be harvested on a sustained yield basis, they estimate future timber volumes. They project the growth rate of forest stands on the basis of species, age, height, diameter,

Inventory is a key to managing the allowable annual cut. Here a forester uses an increment bore to determine the age of a tree (top) and a technician studies air photos to produce forest cover maps (left).

Data from space

In 1972, NASA launched the first in a series of Landsat satellites that have been in continuous operation ever since.

There are two satellites dedicated to monitoring resource management.

Every 103 minutes, they encircle the earth, and they return to the same spot at the same time every 16 days.

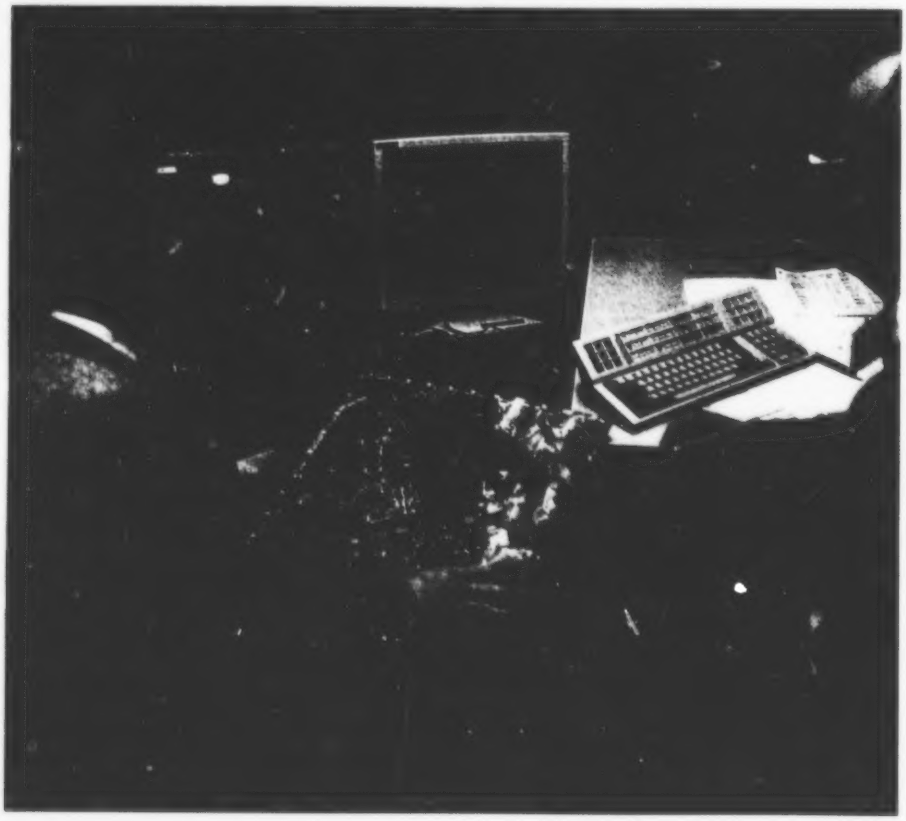
They constantly transmit digital data of the earth's surface, showing for example, clearcuts and areas of diseased trees.

A major value of the satellite data is in showing change in the forest from one year to another.

density and growing conditions of the trees. Forest managers use computer models to simulate different forest management scenarios. These scenarios show how the timber supply might be affected by different silviculture treatments, attacks from pests and fire, changes in land use, changes in the demand for certain species and needs of other resources. The scenarios help the chief forester to set the AAC and help forest managers choose silviculture treatments, prepare protection plans and work with managers of other resources, such as fish, wildlife and water, to develop integrated resource management plans.

Keeping a perspective

The forest industry—and the B.C. economy—depend on having a continuous supply of trees that are accessible for harvesting. That supply depends upon good forest management which, in turn, depends heavily on a good forest inventory. As advances in technology further improve methods of assessing current timber supplies and predicting future supplies, forest managers can continue to improve forest management plans.



Forest managers use computerized inventory data to plan siviculture activities and other forestry practices.

INTEGRATING RESOURCE USES

The Gold Creek watershed lies about eight kilometres south of Cranbrook in the Rocky Mountain Trench. Located in a major lightning belt, the watershed has been ravaged by fire frequently. The latest burn occurred about 1920, creating a forest that now consists of even-aged stands of lodgepole pine.

The watershed is well suited for timber production and has received intensive silviculture treatments. The area has a history of use by ranchers, who graze their cattle there, and by recreationists for hunting and some hiking. A large wildlife population—mainly elk and whitetail deer—live in the watershed. It is also the source of Cranbrook's water supply.

Naturally, all forest land users want to see the watershed managed to benefit or protect the particular resource they use. The management of one resource, however, sometimes

Integrated resource plans reflect the needs of various resources. This site is important for cattle, wildlife, and timber production.

The public has an important role to play in integrated resource planning (top). Timber production is only one of the resource values considered in the planning process.

conflicts with the management of others. During the early 1980s, there were increasing concerns from the community of Cranbrook over water quality. Residents did not want forestry activities, or hunting and ranching access to affect the water supply.

To deal with competing needs, the B.C. Forest Service brought together representatives of the various watershed users to develop a Coordinated Resource Management Plan (CRMP). The CRMP is often used in B.C. to resolve conflicts over the use of rangelands, but it is sometimes used to address other resource conflicts as well. The CRMP is developed jointly by resource users, resource managers and land owners to increase the compatibility of resource uses.

Initially, the Gold Creek watershed planning group hired a forest technologist to do a full year's study of the watershed. From there, the group produced a very comprehensive development plan. It included all road access to the watershed as well as recreation, grazing and forestry practices, and water uses. It developed schedules and restrictions for activities in various parts of the watershed.

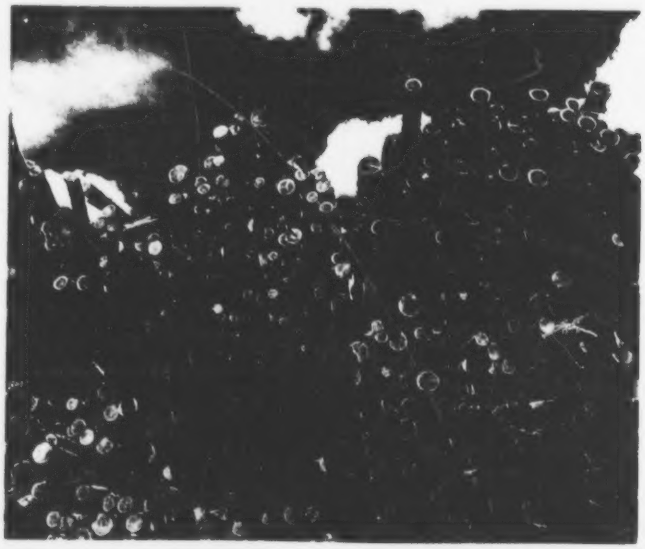
Once the plan was in place, the group did not simply walk away. It continued to meet regularly to review the CRMP and update it as often as necessary. Some years, the plan has required modifications to reflect major changes that have taken place in the watershed. Other years, the plan has required a much simpler updating.

Integrating forest land uses

The planning process for the Gold Creek watershed is not unique. Throughout the province, many agencies and groups manage a wide range of forest and range resources, and resource uses. Forest land is managed for fish, wildlife, domestic livestock, water, recreation, wilderness, timber production and other resources, including mineral and oil deposits, heritage trails and archaeological sites.

It is the job of forest managers in B.C. to manage a process for integrating the objectives for uses of forest land through integrated resource planning. This form of planning is a decision-making process that looks at resources and resource uses, and considers development trends. The process brings together agencies, groups and individuals representing different resource uses. They share their values, ideas and information on resource use and work towards developing a management plan that is both feasible and acceptable.

The B.C. Forest Service is legally responsible for the planning process in the province. It shares the job of managing forest land with holders of leases and licences for the use of



Crown resources. Both the B.C. Forest Service and the lease and licence holders produce integrated resource plans according to provincial standards and guidelines. Major users of Crown rangeland also submit integrated resource plans under the terms of their leases.

Policy and planning levels

To plan and manage the forest in a comprehensive fashion, the B.C. Forest Service has established several policy and planning levels ranging from general to specific. Each level sets the stage for the more detailed levels that follow.

■ Provincial policies

The B.C. Forest Service establishes broad policies, such as range management, timber management, or public involvement policies, that apply to the management of forest land province-wide. These policies conform with legislation, and the general policies and priorities of the B.C. government.

■ Regional policies and plans

Within the provincial policies, B.C. Forest Service regions establish priorities and guidelines. They set general goals to guide the management of rangelands, recreation and timber harvesting and the preparation of integrated resource management plans. These general goals are set after forest managers consult with resource agencies such as the provincial Ministries of Environment; Energy, Mines and Petroleum Resources; Parks; Crown Lands; and Agriculture and Fisheries; and the federal Department of Fisheries and Oceans.

■ Resource management plans for Timber Supply Areas (TSAs)

In each of these plans, the B.C. Forest Service works with other resource agencies and the public to establish the overall direction for managing forest and range resources. These plans integrate resource management objectives for portions of each region, and establish ways of achieving them. For instance, if protecting winter range for mule deer is an objective, the Resource Management Plan may call for selective harvesting in high-quality mule deer winter range.

Other goals may be locating forest roads to avoid grizzly bear feeding areas, seeding clearcuts with grass for livestock or protecting steep slopes to keep soil from sliding into fish habitat. One management objective decided at this level of planning is the allowable annual cut (AAC) for Provincial Forests.

Holders of Forest Licences within TSAs produce Management and Working Plans as statements of how they intend to operate within the Resouce Management Plan. They outline their management strategies for a five-year period.

The identification and protection of archaeological sites is part of the good resource management.

The public has opportunities to take part in the resource planning process.

Local Resource Use Plans

At this level, planning becomes more detailed. It examines the specific conditions and needs of an area within a TSA. Objectives set in the broader Resource Management Plans are refined. The B.C. Forest Service sometimes produces Local Resource Use Plans (LRUPs) for a portion of a TSA that has a number of competing resouce uses and that needs a coordinated plan.

This level of planning is often the most critical for reconciling the views of all agencies and public groups over local issues. Forest managers develop guidelines for the use of individual resources. For instance, they may restrict harvesting to particular seasons.

Most LRUPs are developed through field studies, analyses and local discussions. The plans for the Gold Creek watershed, described at the beginning of this section, are examples of LRUPs.

Resource Development Plans

The last stage in the planning process is to draw up very detailed plans for developing each resource. These must follow the broader management guidelines already approved by the B.C. Forest Service. The Resource Development Plans specify road and harvesting locations, harvesting methods, schedules and specific responsibilities for using, renewing and protecting each resource. For instance, a forest company may plan exactly where and how forest roads and bridges will be built, as well as where strips of trees will be left along a stream-bank to help preserve fish habitat.

Specific prescriptions of forest management practices are required before any machinery moves onto a site. These prescriptions are called Pre-Harvest Silviculture Prescriptions. They are reviewed by other government agencies, advertised in the paper and made available for review by the public.

The complete Resource Development Plan is plotted on maps and circulated with detailed notes among other government agencies before it is approved by the B.C. Forest Service.

The planning procedure

At each planning level, the process for generating integrated resource plans involves the same basic steps. Planning projects adapt these steps to specific regional and local needs:

- Organizing the planning project and developing terms of reference:
  - defining the problem, including the concerns and issues of the resource users and agencies;
  - stating the purpose of the plan;
  - identifying the area to be planned;
  - identifying the planning participants and their roles;
  - defining the process to be used;

  - describing data requirements and collection procedures; and
  - outlining a planning schedule and estimating costs.
- Gathering and analyzing information:
  - documenting natural resource values, present uses, and developments and trends in supply and demand;
  - identifying any special problems and issues; and
  - considering the requirements for mapping and presenting data.
- Developing options:
  - reviewing the terms of reference to ensure that all identified problems have been dealt with;
  - refining the objectives; and,
  - identifying options for addressing the issues, managing resources and resolving conflicts.
- Evaluating and choosing options:
  - evaluating options to select those that best meet the objectives and address the issues;
  - developing a set of alternative objectives to help develop a design for a detailed plan;
  - considering the significance of various options for the resource sectors and users; and
  - selecting management options for further consideration.
- Designing a plan:
  - developing specific guidelines or prescriptions within the set of objectives;
  - evaluating the effectiveness of the plan design;
  - defining the tasks and responsibilities, and establishing a schedule to implement the plan; and,
  - preparing a draft plan for review and revising it as required.
- Monitoring the implementation and reviewing the plan:
  - establishing a system to monitor the implementation of the plan and to fine tune it; and,
  - making provisions for updating and reviewing the plan.

The public's role in integrated resource planning

The integrated resource planning process provides opportunities for the public to influence the management of forest land by identifying resource issues, concerns and preferences. It also gives resource managers a chance to communicate their proposals to the public.

The planning process provides specific opportunities for public involvement at all planning levels and at each step within the planning procedure. For instance, the public is asked to identify concerns and issues, contribute information on resources and their uses, suggest land-use management options, and state a preference for certain options. The public can also comment on an integrated resource plan, state preferences, give

Policies and plans for Tree Farm Licences

The policy and planning process for TFLs is very similar to the process for TSAs.

Holders of TFLs produce broad Management and Working Plans and Five-Year Development Plans.

Like holders of Forest Licences in TSAs, TFL holders produce Pre-Harvest Silviculture Prescriptions for each area they plan to harvest. These prescriptions include all the activities in the rotation of the forest from harvest to harvest.

All TFL plans and prescriptions are integrated resource plans. They must be approved by the B.C. Forest Service.

Forestry workers are deeply concerned about the forestry environment that they work in and that surrounds the communities they live in.

advice on implementing a plan and review field operations.

At the broad planning levels, the public may be asked to comment on policy and regional priorities by responding to discussion papers and questionnaires. The public can review drafts of the Resource Management Plan—including the proposed rate of harvest—and suggest modifications before the plan receives approval.

At local planning levels, public input is a good source of specific information on local sites, resource preferences and issues. This input is provided at public meetings, open houses and field trips, for example. Sometimes, if a plan is especially likely to affect a community or particular group, individuals may be asked to participate on working committees with resource managers.

Forest land planning and the process of consulting government resource agencies, industries, associations and the public may bring forward competing views. Resource use conflicts cannot always be resolved, but the processes of integrated resource planning and public involvement help decision-makers make informed—and hopefully wise—choices.

Not all resource-use conflicts can be resolved but the integrated resource planning process help produce informed decisions on forest and range land.

CHALLENGES FOR THE FUTURE

The forest is a highly complex ecosystem. Researchers will spend many lifetimes learning exactly how trees grow, how each living thing in a forest relates to all the others, how forest management practices affect the ecosystem and much, much more.

In the meantime, forest managers must work with the knowledge and technology that is available now. Just as they look back 25 years and see how much forestry practices have changed, they look ahead 25 years and speculate how much further forestry practices will improve.

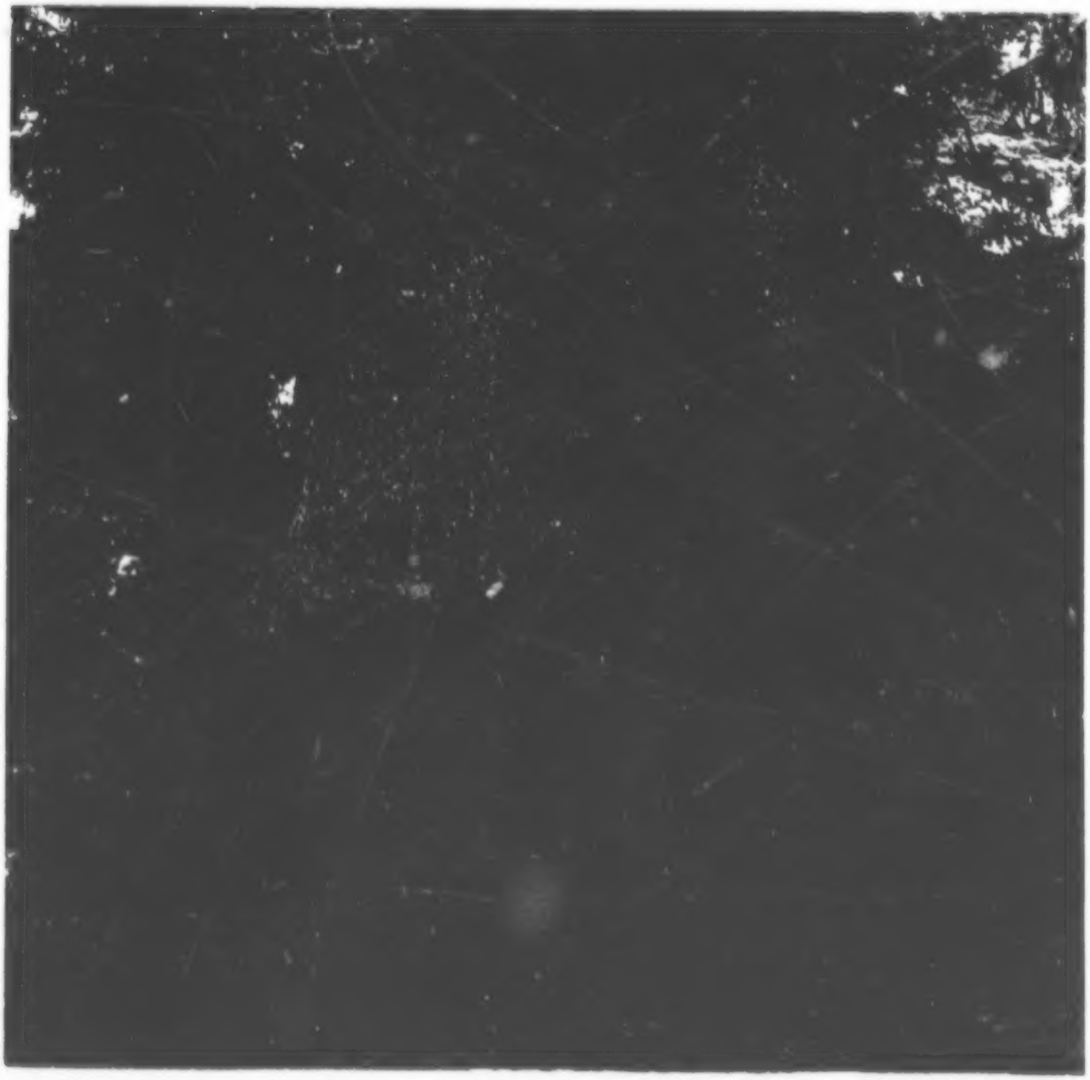
Further research into forest management practices will likely concentrate on two main areas. The first is integrated resource management. Researchers will continue to look for ways to improve the management of a wide range of forest resources. They will research ways to further protect water, fish and wildlife habitat, rangeland, heritage sites and recreation opportunities while maintaining a timber-based economy.

The second main area of research will focus on timber management. Forest managers need

Forest managers need to know how to harvest and grow trees in the most efficient and ecologically appropriate way. For example, they want to become better at rehabilitating damaged sites, preparing planting sites, choosing the best tree species to plant, selecting sound stand-tending practices, and controlling forest pests and fires.

As technology and the knowledge of forest practices expands, forest managers will continue to improve their management procedures. They will refine their methods of taking inventory and of planning forest land use. They will also continue to call for citizen participation in the decision-making process.

That's where your challenge lies. Keep informed about your forest resource. Contribute information to resource planners. Continue to offer your advice. Through your input to the B.C. Forest Service and the forest industry, you can help manage B.C.'s forests.



"What do these forests make you feel? You can find everything in them that you look for, showing how absolutely full of truth, how full of reality, the juice and essence of life are in them..."
--Emily Carr's Journal, 1934

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